MAY 1994

CENTRAL AND SOUTHERN FLORIDA PROJECT

FINAL
INTEGRATED GENERAL REEVALUATION REPORT AND
ENVIRONMENTAL IMPACT STATEMENT

CANAL 111 (C-111) SOUTH DADE COUNTY, FLORIDA

US Army Corps
of Engineers
Jacksonville District
South Atlantic Division

CENTRAL AND SOUTHERN FLORIDA PROJECT
FLOOD CONTROL AND OTHER PURPOSES

CANAL 111 (C-111)
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Responsible Agencies: The responsible lead agency is the U.S. Army Corps of Engineers, Jacksonville District. The responsible cooperating agencies are the U.S. Park Service, the U.S. Fish and Wildlife Service, the South Florida Water Management District, and the Florida Game and Fresh Water Fish Commission.

Abstract: The Canal 111 (C-111) Basin is located in southern Florida. The basin's short-hydroperiod, Everglades ecosystem and its environmental values have deteriorated as the cumulative results of local and Federal modifications for water resources development. The purposes of the study include protection of the natural values associated with the Everglades National Park and maintenance of flood damage prevention within the C-111 basin. All evaluated alternatives provide net flood protection benefits to agricultural activities, as well as partial restoration of environmental values. Alternative 6A produces the most benefits indicative of overall habitat quality improvement, and it provides beneficial effects for indicator species used in the evaluation. Alternative 6A provides about 397 square miles of Everglades habitat in the Shark Slough and C-111-Taylor Slough basins with longer hydroperiods at beneficial depths, and produces 100 percent improvement over base conditions. With alternative 6A in place, and with a modified water operation schedule, a significant degree of restoration appears likely.

THE OFFICIAL CLOSING DATE FOR THE RECEIPT OF COMMENTS IS 30 DAYS FROM THE DATE ON WHICH THE NOTICE OF AVAILABILITY OF THIS FINAL REPORT-EIS APPEARS IN THE <u>FEDERAL REGISTER.</u>

If you require further information on this document, contact:

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NOTE: This report includes an integrated environmental impact statement (EIS) within the report text; paragraphs required for compliance with the National Environmental Policy Act (NEPA) are noted by an asterisk in the Table of Contents.

CENTRAL AND SOUTHERN FLORIDA PROJECT FOR FLOOD CONTROL AND OTHER PURPOSES

CANAL 111 (C-111) SOUTH DADE COUNTY, FLORIDA

FINAL INTEGRATED GENERAL REEVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SYLLABUS

The comprehensive Central and Southern Florida (C&SF) Flood Control Project was authorized by the Flood Control Act of 1948 and modified by subsequent acts, as a plan of improvement for flood control, drainage, and other purposes covering a 16,000 square mile area of both central and southern Florida. The Canal 111 (C-111) project, located in southeastern Dade County Florida, adjacent to the eastern boundary of Everglades National Park (ENP), was authorized as an addition to the C&SF Project by the Flood Control Act of 1962.

In 1968, Congress authorized modification of the C-111 project for construction of the ENP-South Dade Conveyance Canals to provide water supply to Dade County as well as Everglades National Park. The project included enlarging existing canals and construction of new structures and pump stations. For this study, it is assumed that the volume of water in C-111 will not increase. However several projects including the Modified Water Deliveries to Everglades National Park Project, C&SF Restudy, South Florida Water Management District's (SFWMD) Lower East Coast Water Supply study and the ongoing Everglades litigation may impact the operations in the C-111 basin.

The Everglades National Park Protection and Expansion Act of 1989 further stipulated that preparation of the General Design Memorandum for project works within the C-111 basin should include all measures which are feasible and consistent with the purposes of the project to protect natural values associated with Everglades National Park. The Act further stated that the report will provide the status of the natural resources of the C-111 basin and functionally related lands.

This General Reevaluation Report (GRR) provides a reformulation and assessment for completing the authorized project within the C-111 basin. This GRR integrates a feasibility report level of documentation with an Environmental Impact Statement (EIS) to produce a single decision document. The purpose of this report is to provide an assessment of the authorized project works to assure that measures recommended for implementation are feasible and consistent with the purposes of the

C&SF Project. These purposes include protection of the natural values associated with the Everglades National Park, and maintenance of flood damage prevention within the C-111 basin, east of L-31N and C-111.

An array of alternative plans have been formulated and evaluated in coordination with our study partners, the South Florida Water Management District, Everglades National Park and US Fish and Wildlife Service. The plans have undergone extensive coordination with representatives of environmental groups and individuals and agricultural interests in the determination of measures which will satisfy the project objectives.

As a result of this coordination effort, the recommended plan consists of both structural and non-structural modifications to the existing project works within the C-111 basin. Structural components of the plan consist of the construction or modification of nine canals, the construction of a L-31 Tieback levee and S-332D Tieback levee, construction of five pump stations, and replacement of the existing bridge over Taylor Slough within the Park. The plan calls for the removal of existing materials placed along the southerly leg of C-111 with these materials to be used as fill for the L-31W Tieback levee. Non-structural components of the plan include the acquisition of over 11,866 acres of land, including the Frog Pond and Rocky Glades, and the relocation of approximately four residential structures which are expected to be impacted by project implementation.

The recommended plan is expected to restore the natural values of Everglades National Park, and maintain flood protection within the C-111 basin east of L-31N and C-111. The wide aerial extent of the water distribution capability of alternative 6A restores the hydrology in 128 square miles of the Taylor Slough and its headwaters in the Rocky Glades. In addition, the hydroperiod and depths in 1027 square miles of Shark River Slough are beneficially impacted by the higher stages in the Rocky Glades, resulting in a net increase in water volume within Shark River Slough. Restoration of hydrologic conditions which reflect the characteristics of historic water conditions within the study area is expected to provide the framework necessary for natural reestablishment of an ecosystem which existed prior to construction of the basin's flood control project. The recommended plan will provide adequate operational flexibility to incorporate management strategies that will evolve as a result of continued monitoring and studies.

The estimated total cost of the recommended plan is approximately $121,400,000; average annual costs are estimated to be $12,000,000 (May 1993 price levels).

Consideration has been given to all significant aspects of the recommended plan in the overall public interest, including engineering feasibility, and economic, social, and environmental effects. The recommended plan described in this report provides the best solution to the water resources needs within the C-111 basin at this time.

CENTRAL AND SOUTHERN FLORIDA PROJECT FOR FLOOD CONTROL AND OTHER PURPOSES

CANAL 111 (C - 111) SOUTH DADE COUNTY

FINAL INTEGRATED GENERAL REEVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

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SECTION 1

INTRODUCTION

The Canal 111 (C-111) Basin, as shown in Insert "A" on Figure 1-1, is located in southern Florida. The area of focus in this report is located in southeastern Dade County, adjacent to the eastern boundary of the Everglades National Park (ENP). In the 1960's, the area was channelized as part of the comprehensive Central and Southern Florida (C&SF) Flood Control Project. This effort has involved years of extensive work by the US Army Corps of Engineers (Corps), the South Florida Water Management District (SFWMD), and the National Park Service/Everglades National Park, South Florida Center for Science and Natural Resources, as well as continuing participation by a variety of interests in Florida and throughout the Nation.

The study focuses on water supply to ENP, environmental restoration and flood protection for the agricultural activities in the C-111 basin.

This section of the report describes the study's authority, partners, purpose and scope; discusses compliance with the National Environmental Policy Act; and provides a brief overview of the C-111 basin, and other studies, reports and existing projects within the area of study.

1.1 STUDY AUTHORITY

In 1968, the ENP-South Dade Conveyance Canals Project was authorized by PL 90-483, Flood Control Act of 1968. The Act authorized modifications to the existing Central and Southern Flood Control Project as authorized by the 1948 Flood Control Act and 1962 Flood Control Act in the interest of improved conservation and distribution of available water and extended flood protection. A major purpose of this project was for conservation and conveyance of water supplies to meet the long-term needs of urban and agricultural users and the ENP. Improvements to the L-31N borrow canal and a new pump station S-331 enabled delivery of water to Taylor Slough, via L-31W and a new pump station S-332, and the Park's eastern panhandle, via C-111, to meet minimum water deliveries to ENP mandated by PL 91-282. No improvements were required in C-111 to handle the increased water supply. The portion of the 1968 Act which is pertinent to the subject area is quoted as follows:

> *...The project for Central and Southern Florida, authorized by the Flood control Act of June 30, 1948, is further modified in accordance with the recommendations of the Chief of Engineers in Senate Document Numbered 101, Ninetieth Congress, ... and in accordance with House Document Numbered 369, Ninetieth Congress.*

Specific authorization from River Basin Monetary Authorization and Miscellaneous Civil Works Amendments Act of 1970 (PL 91-282) stipulated construction of specifically named canals and other works to deliver water to Taylor Slough and the eastern panhandle of the park. The Act further provided for the delivery to ENP a minimum of 315,000 acre-feet of water according to a monthly distribution.

1.2 PROJECT PARTNERS

The South Florida Water Management District has expressed its intent to be the project sponsor. The SFWMD's outstanding assistance and cooperation contributed greatly to the completion of the study and this general reevaluation report.

In addition to the SFWMD, the ENP, South Florida Center for Science and Natural Resources, and the US Fish and Wildlife Service (FWS) actively participated in the study by assisting in the evaluation of alternatives for the environmental restoration of the C-111 study area.

1.3 STUDY PURPOSE AND SCOPE

1.3.1 Study Purpose

This report covers the Canal 111 (C-111) basin and other parts of the Central and Southern Florida Project which affect flows to and through the basin including the borrow canal to L-31N and the borrow canal to L-31W. The purpose of this general reevaluation report (GRR) is restoration of the ecosystem in Taylor Slough and the eastern panhandle of ENP that were affected by construction of the flood control project in the C-111 Basin. The study also focuses on preserving the current level of flood protection for the agricultural activities in the C-111 basin.

This report provides a recommended solution to these problems which will provide both flood protection and vastly increase management options for the benefit of the environment and the economy. It is the intent of this report to select a plan that will have the operational capability and flexibility to provide restoration of the ecological integrity of Taylor Slough and the eastern panhandle areas of the Everglades and flood protection to the agricultural interests adjacent to C-111.

The GRR is the first step in a two-phase design process. The focus of the GRR is to develop the structural plan which provides the greatest flexibility in providing environmental restoration of the study area while maintaining flood control. The second phase will consist of detailed design studies and development of an operational plan. While a preliminary operational plan will be submitted with this report, a refined operation plan will be developed in coordination with ENP, FWS, SFWMD and

CENTRAL AND SOUTHERN FLORIDA PROJECT

FIGURE 1-1

other agencies prior to project construction. The study has been conducted in accordance with current Federal water resources planning procedures and guidelines, with assistance and support from numerous Federal and State agencies, and other interests.

1.3.2 Study Area

The area of focus in this report is located in southeastern Dade County and is depicted in Figure 1-2. The study area's northern boundary is a line drawn east from S-331, the divide control structure, and west on the southern limit of the eight-and-one-half square mile area and west by Shark River Slough located in ENP. The eastern boundary varies generally along a line through the ridge structures S-194 and S-196 to Homestead and then parallels Card Sound Road. The southern boundary is Florida Bay. The area is low with the land surface south of Homestead generally sloping to the southeast. Ground elevations range from just above sea level to 7.0 feet, NGVD.

The C-111 study area basin includes the borrow canal to L-31N south of S-331, the borrow canal to L-31W, and canals 111, 110, and 109.

1.4 NATIONAL ENVIRONMENTAL POLICY ACT REQUIREMENTS

The National Environmental Policy Act of 1969 (NEPA), as amended, is the nation's charter for environmental protection. NEPA establishes policy, sets goals, and provides means for carrying out the policy. Section 102(2) of the Act contains action-forcing provisions to make sure that Federal agencies act according to the letter and spirit of the Act, including a provision to prepare a detailed statement - now called an environmental impact statement (EIS) - on the effects of a major Federal action that significantly affects the human environment. The Federal regulations for implementing the procedural provisions of NEPA were published by the Council on Environmental Quality (CEQ) in the Code of Federal Regulations (CFR) as 40 CFR Parts 1500-1508 (43 Federal Register 55978-56007, November 29, 1978).

This report documents the Corps study of environmental restoration and maintenance of flood control in the C-111 basin in compliance with NEPA requirements. It employs two concepts established in CEQ's NEPA regulations - integration and tiering - that are appropriate to the planning and design process and schedule for the C-111 basin.

Integration is based on the CEQ provision to combine documents, which states that *"any environmental document in compliance with NEPA may be combined with any other agency document to reduce duplication and paperwork"* (40 CFR 1506.4). Corps regulations permit an EIS ("environmental document") to be either a self-standing document combined with and bound within a feasibility report ("agency document"), or an integration of NEPA-required discussions in the text of the report. In view of the environmental nature of the C-111 basin, and to consolidate documentation into one consistent report, the Corps elected to integrate discussions that could have appeared as an EIS with the feasibility report. Sections in this integrated report that include NEPA-required discussions are marked with an asterisk in the Table of Contents to assist readers in identifying such material.

Tiering was established by CEQ to provide *coverage of general matters in broader environmental impact statements (such as national program or policy statements) with subsequent narrower statements or environmental analyses (such as regional or basin-wide program statements or ultimately site-specific statements).... Tiering is appropriate when the sequence of statements or analyses is...from an environmental impact statement on a specific action at an early stage (such as need and site selection) to a supplement (which is preferred) or a subsequent statement or analysis at a later stage....Tiering in such cases is appropriate when it helps the lead agency to focus on the issues which are ripe for decision and exclude from consideration issues already decided or not yet ripe* (40 CFR 1508.28 and 1502.20). Tiering has been applied to proposed Federal actions for the reevaluated C-111 portion of the C&SF Project as follows:

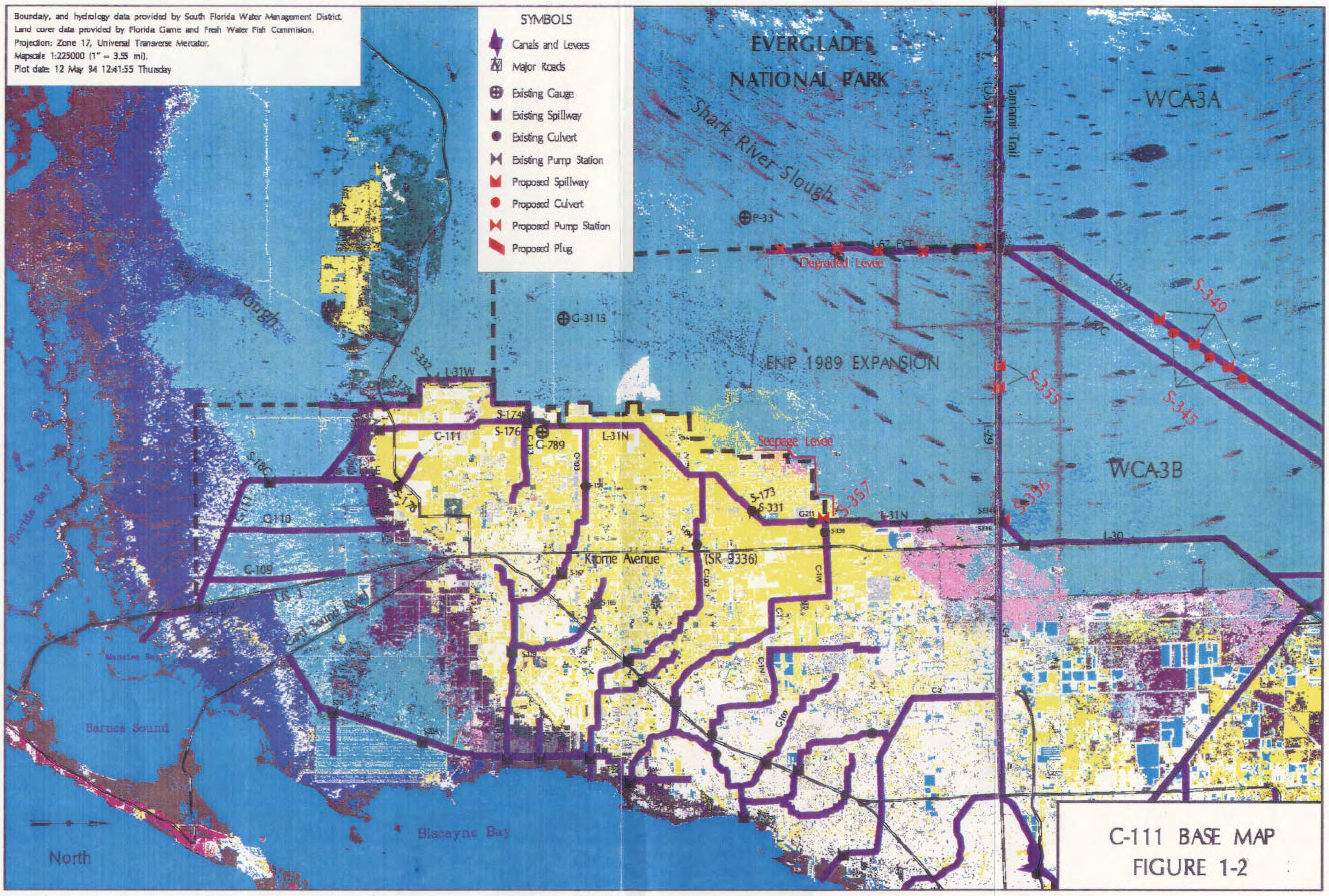
- The C-111 project will be formulated in two stages: the facilities planning stage and the operation planning stage. The facilities plan formulation for locations and capacities of pumps, canals, levees and required appurtenances is reported in this integrated GRR-EIS for approval in 1994. The GRR-EIS is, therefore, a programmatic EIS and a site-specific EIS.

- Selection of the preferred plan of operation of the project facilities will be accomplished during 1994-1996, and the impacts of the recommended operation will be published in a supplement to the final GRR-EIS. The Supplement to the EIS will be published prior to completion of construction.

1.5 HISTORY OF THE AREA

The existing Canal 111 (C-111) and adjacent canals are the result of a number of changes from the initially conceived plan for this area. It is part of the Central and Southern Florida Project which had its genesis as a multipurpose water resources project initiated in the 1940s.

The initial concept for South Dade County contained in the 1947 comprehensive report called for the area to be protected by a levee. This levee would protect the area on the east and south from ocean tides driven by hurricanes. On the west, the levee would protect the area from flood waters in the Everglades. Spillways and culverts in the east and south walls of the levee would control discharge from the canals and maintain canal water levels high enough to prevent salt water intrusion. At that time, it was envisioned that the C-111 basin would become developed.



C-111 BASE MAP
FIGURE 1-2

Later analysis led to a revision of the project. A series of canals, C-107 through C-112, were proposed in lieu of the southern portion of the levee. This iteration was contained in the Survey Review Report for South Dade County published in November 1959. These canals were proposed to go to tidewater: C-107 and C-108 to Card Sound, C-109 to Barnes Sound, and C-110 through C-112 to Long Sound and Florida Bay. Salinity control structures were included between the one- and two-foot contour. The US Fish and Wildlife Service recommended that Canals 108 through 111 be terminated at the 1-foot contour to allow the water to spread over a wider front and flow more gradually through ENP in accordance with the natural condition. The problem with this proposal was that the canals would not carry the design discharge unless excavated to open water on the coast. The staff of the FWS further suggested an east-west canal connecting the ends of C-111 and C-110 with C-109 as a possibility. The staff of the ENP was less specific but wanted to hold southward extension of C-110 and C-111 to a minimum to facilitate the spread of water over Park lands as it flowed toward Florida Bay.

Further changes were made during preparation of the General Design Memorandum (GDM). The Park wanted C-110 through C-112 terminated at the Park boundary. The Fish and Wildlife Service was still requesting termination of the canals at the 1-foot contour. Also during this period a private firm, Aerojet General Corporation, purchased a large tract of land in the area. At the time, this corporation was to construct a rocket engine testing facility (which was completed later). Since the canal would be large enough to convey barges carrying the rockets to Cape Canaveral, the firm also supported connecting the canal to C-109. The resultant alinement of C-111 was a trade-off with the existing diagonal configuration being more cost effective. This alinement is shown in Figure 1-3. The Aerojet facilities are no longer in operation.

One other change made during project construction has had a significant effect on operation of the system. The original design included S-18C, located upstream from the coast with the end of the canal open to Barnes Sound, as the canal's downstream salinity barrier. Concerns were raised feared that salt water would move up the canal and possibly contaminate the freshwater aquifer or spill over the south bank through the gaps, destroying the portion of ENP south of C-111. During construction of the canal, these interests became very vocal and mounted a national campaign to construct a structure at the end of the canal. As part of the construction procedure, a bypass for US Highway 1 was used while the bridge over C-111 was constructed. About the time the bypass was to be removed, the controversy over the open end of the canal reached a peak. As a temporary solution, a plug and culvert structure were placed in the canal immediately downstream of the US Highway 1 bridge. The plug was to be removed for flood control purposes and also for

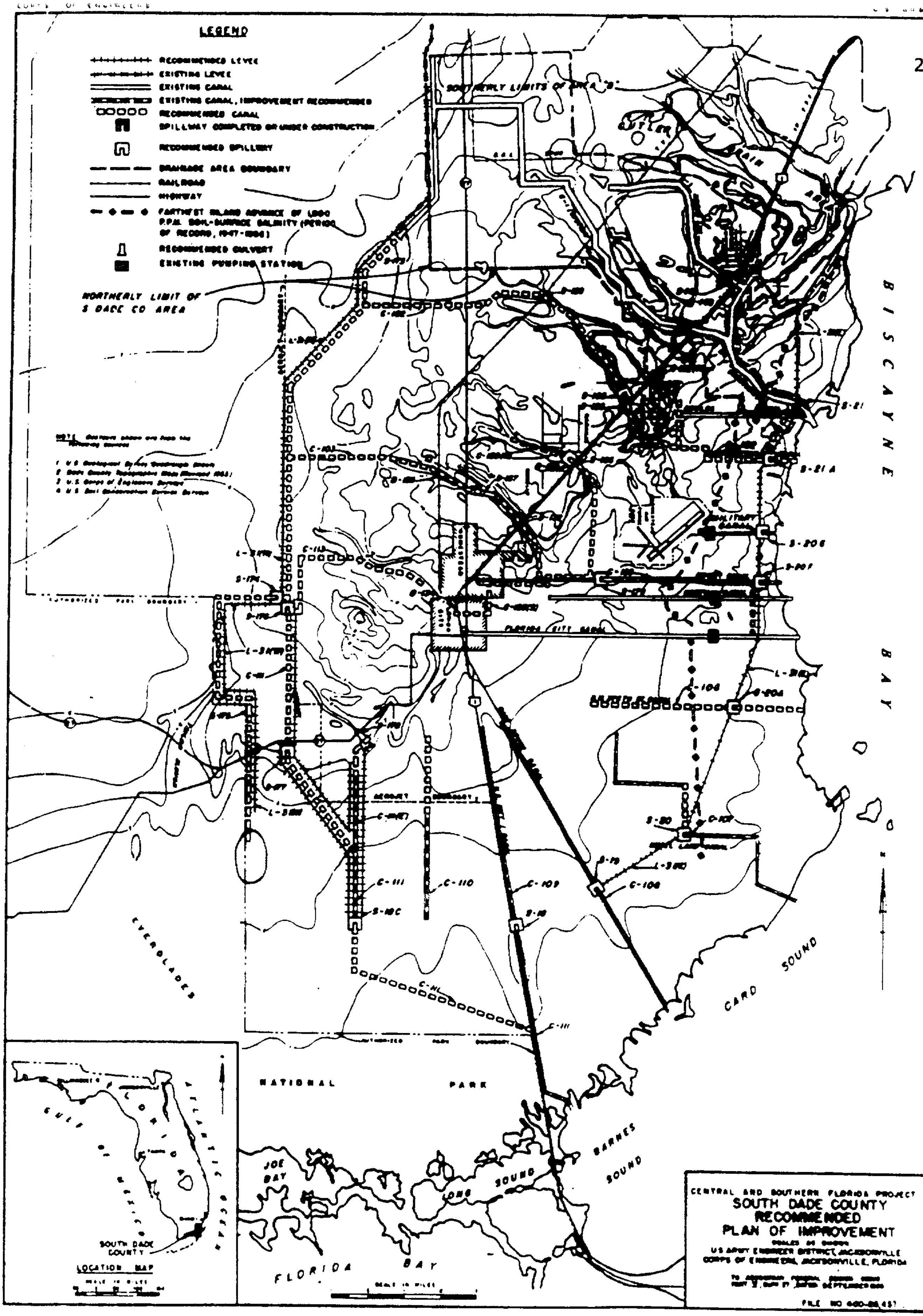

LEGEND
RECOMMENDED LEVEE
EXISTING LEVEE
EXISTING CANAL
EXISTING CANAL, IMPROVEMENT RECOMMENDED
RECOMMENDED CANAL
SPILLWAY COMPLETED OR UNDER CONSTRUCTION
RECOMMENDED SPILLWAY
DRAINAGE AREA BOUNDARY
RAILROAD
HIGHWAY
RECOMMENDED CULVERT
EXISTING PUMPING STATION
NORTHERLY LIMIT OF S DADE CO AREA
SOUTHERLY LIMITS OF AREA "B"
BISCAYNE BAY
CARD SOUND
BARNES SOUND
FLORIDA BAY
JOE BAY
NATIONAL PARK
EVERGLADES
S-21
S-21 A
C-111
C-110
C-109
S-18C
LOCATION MAP
SOUTH DADE COUNTY
GULF OF MEXICO
ATLANTIC OCEAN
CENTRAL AND SOUTHERN FLORIDA PROJECT
SOUTH DADE COUNTY
RECOMMENDED
PLAN OF IMPROVEMENT
US ARMY ENGINEER DISTRICT, JACKSONVILLE
CORPS OF ENGINEERS, JACKSONVILLE, FLORIDA

FIGURE 1-3

passage of Aerojet barges. However, the plug was never removed for navigation purposes.

Another change made during the GDM was based on ENP's goal to receive as much water as possible from the C&SF Project. The ENP requested that excess water from the western portion of south Dade County be provided to the Park through Taylor Slough. L-31W was added for this purpose to provide gravity flow.

A number of other changes to the C&SF Project upstream of C-111 have had an impact in the C-111 basin. In 1968, the ENP-South Dade Conveyance Canals were authorized (PL 90-483). A major purpose of this system was to promote conservation and conveyance of water supplies to ENP and to the expanding agricultural and urban areas of south Dade County. As a part of the conveyance system, necessary modifications to the C&SF Project were constructed upstream of L-31W (including improvement of the L-31N borrow canal upstream of its confluence with C-103 and addition of the pump station S-331) to enable adequate delivery of water to Taylor Slough and the Park's eastern panhandle. No canal improvements were made to the borrow canal for L-31W or C-111 as a part of the conveyance system. However, S-332 was added as a part of the system to provide water deliveries to Taylor Slough from the L-31W borrow canal. The S-332 pump capacity is 165 cfs and it is operated to satisfy the minimum monthly water delivery requirements of Taylor Slough as specified in PL 91-282. In 1976, the specific operation of S-332 was agreed upon in an Agreement and Permit signed by the Corps, National Park Service, and the C&SF Flood Control District (now SFWMD). Although the total annual volume of 37,000 acre-feet to be delivered to Taylor Slough remained the same, the monthly distribution used in the agreement varied slightly from that prescribed by PL 91-282. Since construction of S-332 was completed in 1980, water deliveries have been provided to Taylor Slough to satisfy the minimum delivery requirements of the 1976 Agreement and Permit.

By the early 1980's, it was becoming clear that the structural and operational water management system had significantly contributed to the decline of the Park's natural resources. However, there were not adequate hydrologic or ecologic data available to fully define the hydrologic needs of the ecosystem nor to determine how the water management system should be modified. In order to allow collection of the required data, Congress enacted the Experimental Program of Modified Water Deliveries to ENP (PL 98-181), which allowed the minimum delivery schedule to be temporarily abandoned in order to test alternative plans for delivering water to the Park.

The test is being conducted through an iterative process with each step building on information obtained in previous iterations. The first test was initiated in 1985 when a Letter of Agreement (LOA) was signed by the Corps, SFWMD, and ENP to change the experimental program started in 1983. To date there have been six

Addenda to the LOA and five associated iterations of testing.. Addendum 1 presented the operational procedures used in a 2-year test of the rain-driven plan for water deliveries to the ENP that ended on June 14, 1987. Addendum 2 prescribed operational procedures for the rain-driven plan used through July 10, 1988. Addenda 3, 4, and 5 represented continuation of the operational procedures contained in Addendum 2. On July 12, 1985, an agreement was reached between the SFWMD and the Frog Pond farmers in response to the Kendall et. al. v. Marsh, et. al. lawsuit. This agreement permitted the experimental program to continue without further litigation.

Section 107 of P.L. 102-104 authorized continuation of the experimental program until modifications to the C&SF project, authorized by Section 104 of Public Law 101-229 (Everglades National Park Protection and Expansion Act of 1989), are completed and implemented.

From 1983-1988 a GDM was prepared. The purpose of the study was to complete the authorized plan of improvement for flood control, environmental enhancement and water management in the C-111 basin as constructed. The recommended plan focused on preventing large, damaging discharges to Barnes Sound via S-197 and to increase flows to northeast Florida Bay via flows from lower C-111.

From 1988 to 1990, several actions developed which changed the scope and schedule for completion of the C-111 report. Seagrass die-offs were observed in portions of Florida Bay although the precise causes were unknown. As a result, ENP requested that additional studies be performed to more fully evaluate potential means of restoring natural hydrologic conditions to Taylor Slough.

In 1989 the Everglades National Park Protection and Expansion Act was enacted. Under Section 104 (j): Protection of Natural Values, *The Secretary of the Army is directed in analysis, design and engineering associated with the development of a general design memorandum for works and operations in the "C-111 basin" area of the East Everglades, to take all measures which are feasible and consistent with the purposes of the project to protect natural values associated with Everglades National Park.* This Act authorized the construction of modifications to the Central and Southern Florida Project to improve water deliveries to the Park, and to the extent practicable, permits steps to restore the natural hydrologic conditions within the Park. The Act states that these modifications are "justified by the environmental benefits to be derived by the Everglades ecosystem in general and the Park in particular".

The FWS submitted a proposal in 1989 to revise their Fish and Wildlife Coordination Act (FWCA) report, including an assessment of benefits and impacts to fish and wildlife resources. They again proposed a structural feature to complement the preferred alternative in the GDM. The FWS proposed an east-west spreader canal between C-111E and US Highway 1. The FWS also proposed the plugging of

C-109 and C-110 to promote sheetflow and to provide dry season refugia. Sheetflow would be provided by overflows from C-111 through gaps in the southern spoil mound.

In June 1993, the Corps, ENP, and SFWMD initiated the Experimental Program of Water Deliveries to Everglades National Park - Taylor Slough Iteration, the sixth iteration of the experimental testing program. This test will continue water deliveries to northeast Shark River Slough and increase water deliveries to Taylor Slough at S-332 up to 500 cubic feet per second (cfs).

From 1989 to the present, the Corps has worked diligently with the SFWMD, FWS and ENP to address plans which would protect the natural values associated with ENP.

1.6 PRIOR STUDIES, REPORTS AND EXISTING PROJECTS

1.6.1 Modified Water Deliveries to Everglades National Park

The Modified Water Deliveries to Everglades National Park project was authorized by the Everglades National Park Protection and Expansion Act, Public Law 101-229. The purpose of the project is to provide for structural modifications to the C&SF Project to enable the restoration of more natural water flows to Shark River Slough in ENP. The project is being implemented by the Corps in conjunction with the acquisition of about 107,600 acres of land by the Department of Interior. These lands will be incorporated into ENP as shown in Figure 1-4.

The General Design Memorandum for the project was approved by the Assistant Secretary of the Army (Civil Works) in May 1993. The Record of Decision for the Environmental Impact Statement was also executed in May 1993. Currently, detailed engineering and design is underway. The first of five Feature Design Memoranda was approved in December 1993. Land acquisition for the levee, canal, and pump station for the flood mitigation system in the 8.5-square-mile area is underway. The project construction is scheduled for completion in 2003. A more detailed project description is in section 3.2.

1.6.2 South Florida Water Management District Interim Plan for C-111 Basin

In 1989, the South Florida Water Management District proposed the Interim Plan for the C-111 basin. The objectives of the plan were to (1) reduce the duration of large discharge events at S-197 associated with removal of the earthen plug, (2) increase the frequency and distribution of flow to the ENP Panhandle by increasing flow through the gaps in the C-111 canal, (3) raise the canal stage in L-31N between S-335 and C-1W to reduce seepage into L-31N canal and enhance the hydroperiod in Northeast Shark River Slough, and (4) maintain existing levels of flood protection.

The objectives were accomplished by specific structural additions and/or changes in operational criteria that included the following: (1) addition of 10 - 84 inch gated culverts at S-197, (2) modification of gaps in C-111 south bank spoil mound to enhance flow of water to ENP eastern panhandle, and (3) installation of a new gated structure G-211 immediately south of the junction of L-31N canal and C-1.

1.6.3 Everglades SWIM Plan

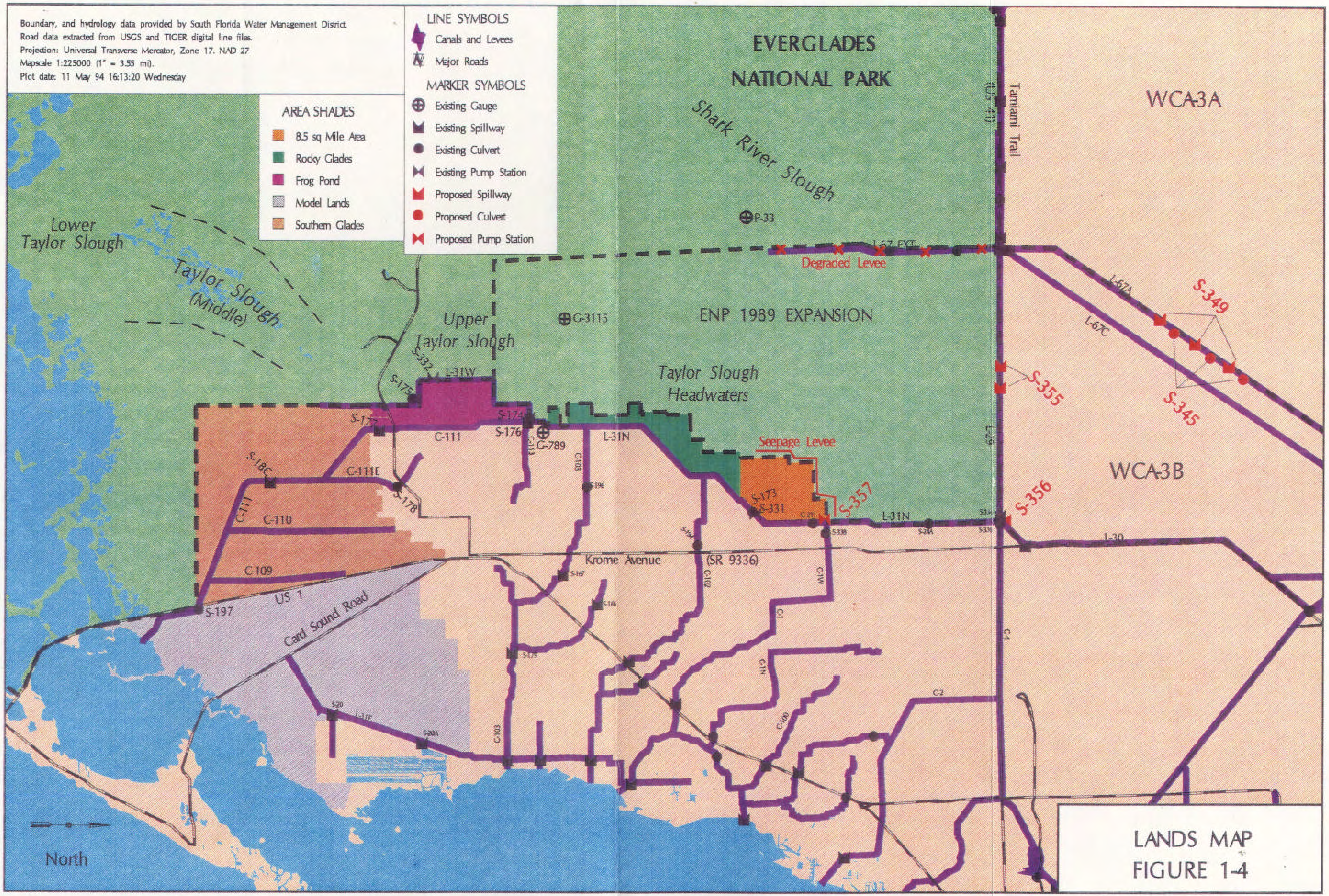
The Surface Water Improvement and Management (SWIM) Plan for the Everglades was published by the South Florida Water Management District on March 13, 1993. The SWIM plan for the Everglades describes the Everglades development and management history, summarizes present knowledge, and provides an overview of current conditions. The plan then integrates proposed and existing programs to address various aspects of water resource management in the Everglades, such as water quality, water quantity (hydroperiod), flood control, control of exotic plants and environmental enhancement. The plan also provides a funding strategy for the Everglades restoration initiative which deals largely with improving the quality of water entering the Everglades as agricultural runoff from the Everglades Agricultural Area.

The SWIM plan has been further strengthened with the passage of the "Everglades Forever" Act in May 1994.

1.6.4 Frog Pond Reconnaissance Report

This study was authorized by PL 100-676 for the purpose of determining the need for an internal drainage system in the Frog Pond Agricultural area in South Dade County. The purpose of the study was to evaluate the feasibility and Federal interest of resolving agricultural flood control problems in the Frog Pond. Approximately 80 percent of the Frog Pond is used for agricultural purposes, mainly tomato farming. The area of Frog Pond not used for farming consists of upland tree hammocks and wetlands.

Although economically feasible plans were identified in this study, the District Engineer recommended that no further Federal action be undertaken at this time for two policy reasons. First, the requirements for local cooperation for the C-111 project, as well as for other elements of the C&SF Project stipulate that local interests are responsible for construction and maintenance of lateral drainage facilities as necessary to realize the benefits made available by the improvements in south Dade County. Secondly, a plan to reduce flood damage in the Frog Pond would violate Federal regulations restricting the provisions of benefits for a single property owner, in this case, the South Dade Land Corporation. No further evaluation was conducted to determine whether the plans were implementable with respect to environmental



LANDS MAP
FIGURE 1-4

impacts. Refer to section 2.2.2 of this report for more detailed information on the Frog Pond area.

1.6.5 Central and Southern Florida Project Comprehensive Review Study

The Central and Southern Florida (C&SF) Project Comprehensive Review Study was authorized by Section 309(l) of the Water Resources Development Act of 1992 and by two resolutions of the Committee on Public Works and Transportation, United States House of Representatives, dated September 24, 1992. These authorizations direct that the Corps reexamine the C&SF Project to determine if modifications should be made to the project in the interest of environmental quality, water supply, and the Everglades and Florida Bay ecosystems.

The study will generally include the entire C&SF Project with the exception of the Upper St. Johns River basin, which is a separate hydrologic basin not considered part of the Everglades ecosystem. Two of the most critical areas to be addressed concern the environmental conditions of the Everglades and Florida Bay. The study will reexamine the C&SF Project in light of current demands to determine the feasibility of structural or operational changes to restore the Everglades and Florida Bay ecosystems while providing for other water related demands. The reconnaissance study was initiated in June 1993 and will be completed in 18 months.

1.6.6 Florida Department of Transportation US 1 South

The Florida Department of Transportation (FDOT) is in the process of widening US 1 from Key Largo to Card Sound Road (Florida City, Florida). The plan involves widening the existing road for another 2 lanes to and from the Florida Keys. The plan is under development and construction is currently scheduled for 1995. The FDOT plans to restore Canal 109 and Canal 110 and the adjacent disposal mounds to natural ground. This will restore sheetflow. Twenty two-foot diameter culverts under US Highway 1 are planned.

1.6.7 Hole-in-the-Donut Restoration

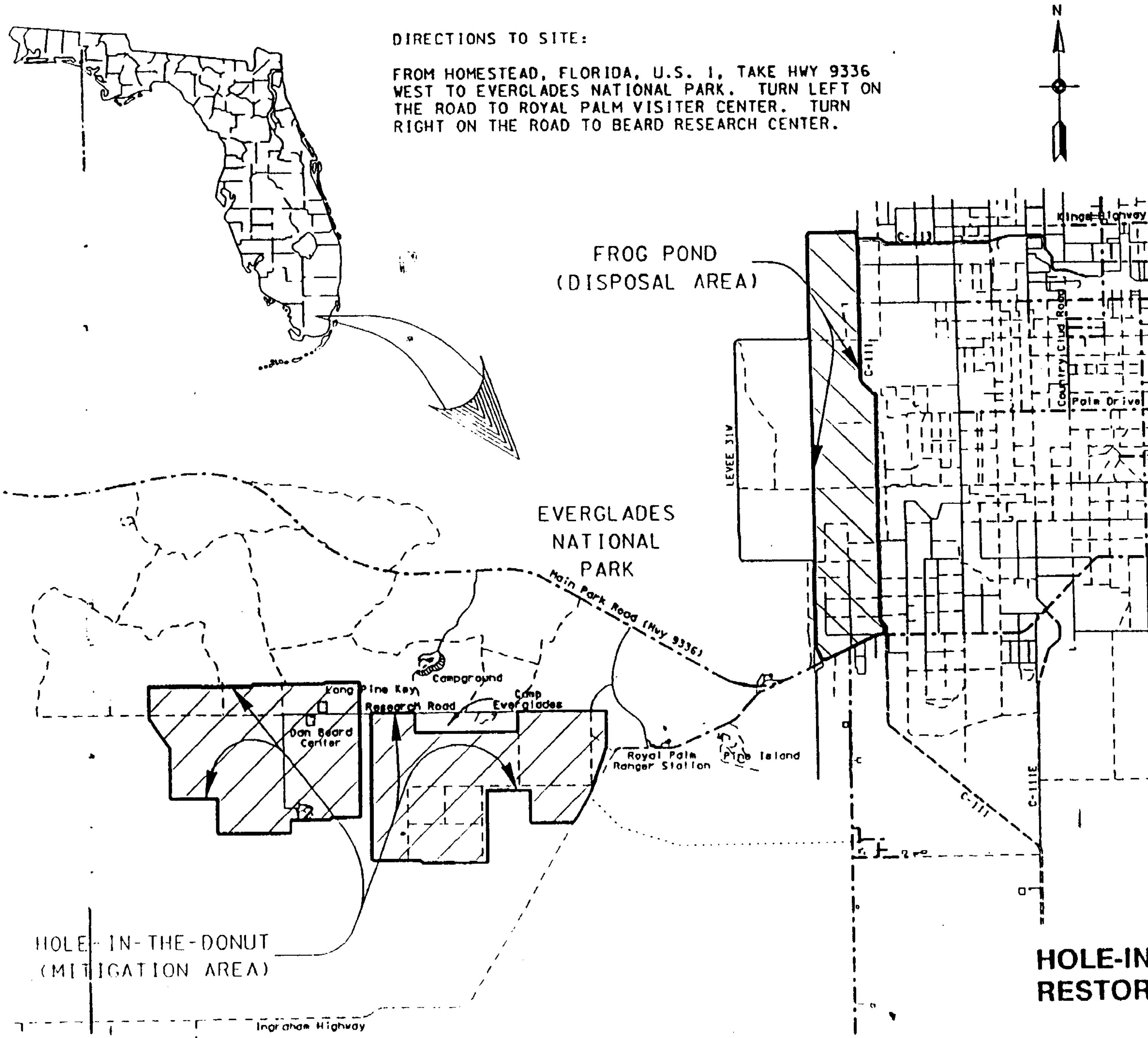
The ENP has submitted a dredge and fill permit under Section 404 of the Clean Water Act for restoration of the Hole-in-the-Donut (See Figure 1-5). The Hole-in-the-Donut area was used for agriculture until the 1970's when it was incorporated into the park. Since that time, it has been overgrown with Brazilian pepper trees that have completely eliminated the native habitat. ENP has unsuccessfully attempted a number of methods to eliminate the trees and restore the natural conditions. The only method found to be successful is to remove the "rock plowed" soil (about 9") down to the native limestone rock. The disposal area identified for this project is the eastern half of the Frog Pond, approximately 3,083 acres. The disposal material will add approximately 2 to 3 feet of elevation to this area of the Frog Pond. Early estimates for completion of the project are approximately 15 years.

1.6.8 Save Our Rivers Program

The State of Florida's Save Our Rivers (SOR) Program uses bond proceeds, supported by the general revenue portion of the State's Documentary Stamp Tax, to acquire lands for the purposes of water management, water supply, and the conservation and protection of the State's water resources. Manageability, surface and ground water systems, and the formation of corridors for the critical interaction of wildlife populations are major considerations in the land acquisition process. Prime requisites in managing these public lands are to ensure that the water resources, fish and wildlife populations, and native plant communities are maintained in an environmentally acceptable manner, and made available for appropriate outdoor recreational activities consistent with their environmental sensitivity. Figure 1-4 shows lands contained in this program for the C-111 basin.

The Florida Legislature approved the Southern Glades (C-111) for land acquisition under the SOR Program. The SFWMD is responsible for acquiring critical water resource lands for the SOR Program in the C-111 basin. Land acquisition in the C-111 basin began in the 1980's, and as of 1993, approximately 27,850 acres have been acquired as part of the Southern Glades program. At the present time, about 3,260 acres remain to be acquired under this program.

Additional property within the C-111 basin is being pursued under the Save Our Rivers Program including the "Frog Pond" area and the transitional land (Rocky Glades).



HOLE-IN-THE-DONUT RESTORATION

FIGURE 1-5

SECTION 2

EXISTING CONDITION/AFFECTED ENVIRONMENT

This section provides an overview of the resources that currently exist within the C-111 basin.

2.1 GEOLOGY AND SOILS

The unconfined Biscayne Aquifer underlies an area of about 3,000 square miles in southeast Florida extending from southern Palm Beach County southward through Broward County to South Dade County. The aquifer is wedge-shaped in section with its deepest portions about 100 to 400 feet in depth along the coast, thinning to a few feet in thickness along the western limits of these coastal counties. This huge fresh water storage reservoir is highly productive everywhere along the coastal ridge and for a considerable distance to the west. The permeable limestone of the aquifer is shielded against upward intrusion of saline water from the Floridan Aquifer by relatively impermeable beds of clay and marl. However, there is no shield against the encroachment of sea water near the coast.

Groundwater in the aquifer flows primarily west to east. However, the direction of flow may be influenced by rainfall, drainage canals, or well fields. Fluctuations in groundwater levels are seasonal. Groundwater levels in the study area are influenced by water levels in adjacent canals.

The surficial soils of south Dade County are distinctly related to the natural province in which they occur. Soils of the poorly drained lowlands of the Mangrove Swamp and Coastal Marshes are composed largely of peat and muck. Calcitic marl is also dominant in the Everglades.

In the study area, the Biscayne aquifer is composed of permeable limestones of the Miami Oolite Formation, which is underlain by marls, limestones, and sandstones (Fort Thompson Formation), and the Tamiami Formation. All three geologic formations are highly permeable with varying transmissivities.

The Miami Oolite (Pleistocene age) is a soft, white, solution riddled limestone formation. The solution holes give the limestone a honeycombed pattern which makes the formation highly permeable. The solution holes are often filled with silt, clay, or sand.

The Fort Thompson Formation (Pleistocene age) consists of a series of alternating layers of marine, brackish water and freshwater limestones. The Fort

Thompson Formation is a pale orange to yellowish gray, porous to very porous limestone.

The Tamiami Formation (Miocene to Pliocene age) consists of a number of different lithologies. The top of the formation is characterized by low permeability, soft limestones, dolosilts, and calcareous sands, all underlain by sandy, fossiliferous limestone.

Although no new subsurface investigations were performed for this report, numerous core borings were obtained previously along the alignment of L-31W borrow canal, C-111, and across the alignment of the canals in the vicinity of S-174, S-175, S-176, S-331, S-332, and S-177. These borings, which are representative of the area's geologic conditions, show highly porous, solution - riddled limestone at or near the surface overlying 10 to 30 feet of medium-hard to hard oolitic limestone.

A subsurface investigation will be performed during the detailed design phase to supplement existing data. A minimum of two holes per pump station and one hole per culvert structure will be drilled. Core borings will be drilled where needed for any proposed canals and levees. Further geologic information can be found in this report in Appendix B, Geotechnical Investigations.

2.2 WATER MANAGEMENT

2.2.1 Plan For Water Control - ENP-South Dade Conveyance System.

2.2.1.1 South Dade County

The purposes of the project works in South Dade County are to remove the 40-percent standard project flood runoff from the effective drainage area, to reduce depth and duration of larger floods; provide water control to prevent overdrainage in the area; prevent saltwater intrusion; and provide facilities to convey up to 500 cfs to Everglades National Park when normal runoff is available. The ENP-South Dade Conveyance System modified the existing project works in South Dade County.

2.2.1.2 Water Supply

The ENP-South Dade Conveyance System was authorized for the purpose of improving the supply and distribution of water supplies to Everglades National Park, and for expanding agricultural and urban needs. Before supplemental water is introduced into the system, canal stages are permitted to recede approximately 1.5 feet below the design optimums. The design optimums were established as shown below in Table 2-1. The above does not include the upstream reaches of the coastal salinity control structures where the design optimum will be maintained.

Table 2-1

Optimum Stages in ENP-South Dade Conveyance System

Canal	Reach	Elevation * (Feet, NGVD)
Levee 31(N) Borrow Canal	U.S. 41 to S-331	5.0
Levee 31(N) Rem. Borrow Canal	S-331 to S-176	5.5
Canal 111	S-176 to S-177	4.5
Canal 111	S-177 to S-18C	2.0
Levee 31(W) Borrow Canal	S-174 to S-175	4.5
Canal 103	L-31(N) Rem. to S-167	5.5
Canal 103	S-167 to S-179	3.5
Canal 103	S-179 to S-20F	2.0
Canal 102	L-31(N) Rem to S-165	5.5
Canal 102	S-165 to S-21A	2.0
Canal 1	S-319(N) to S-148	5.0
Canal 1	S-148 to S-21	2.0

* All elevations shown above and hereafter are reference to National Geodetic Vertical Datum (NGVD).

Optimum and design water levels in the project canals are established on the basis of desirable water control conditions in each area, i.e., optimum groundwater levels, intake and/or discharge structure elevations and removal rates for flood control. Along the east coast salinity control is included as a requirement of canal-level design criteria. Optimum water levels in the project canals are periodically adjusted based on operating experience, changed land uses and to better meet project objectives and changing conditions.

2.2.2 Overall Plan For Water Control - Everglades National Park.

In House Document 90-369 preservation of Everglades National Park was recognized as a project purpose and that available water should be provided on an equitable basis with other users. A minimum water supply to Everglades National

Park (ENP) from the C&SF Project was guaranteed in June 1970 by PL 91-282. This law stipulated that a annual minimum of 315,000 acre-feet would be distributed to the Park and specified the monthly allocation. This included 270,000 acre-feet to Shark River Slough via the S-12's, 37,000 acre-feet to Taylor Slough at S-332, and 18,000 acre-feet to the Eastern Panhandle at S-18C. Senate Document 91-895, which accompanied the law, provided a formula for deciding when the 16.5 percent quantity applied. The formula was found to be faulty and hasn't been applied since the earliest months of the application of this Act. PL 91-282 did not specify the origin of ENP water deliveries, but guaranteed the quantity to be delivered. Discharges are allocated from Lake Okeechobee. Transfers from WCA No. 3A conveyed to Taylor Slough and the Eastern Panhandle whenever local runoff is insufficient to meet the minimum monthly release criteria at S-332 and S-18C, respectively.

PL 98-181, and subsequent acts, have authorized the Corps of Engineers to modify the schedule of water deliveries to ENP and to conduct the Experimental Program of Modified Water Deliveries to Everglades National Park. The Experimental Program has consisted of a series of iterative field tests for the purpose of collecting hydrologic and biologic data with the ultimate goal being the development of an optimum water delivery plan for ENP. The Experimental Program is providing a degree of immediate improvement in water deliveries and is also allowing collection of hydrologic and ecological data. This data will be used to identify correlations between water management and the ecological well-being of Everglades National Park. A General Design Memorandum (GDM) for Modified Water Deliveries to Everglades National Park has been approved. This report describes the Corps plan for modifying the existing water management system to enable improved water deliveries to the park. The project was designed to provide maximum operational flexibility so that as more is learned about the best water management operation for restoration, the project's structural features can be operated accordingly. Currently, the project is being implemented in conjunction with the Experimental Program of Modified Water Deliveries.

ENP-South Dade County Conveyance System was authorized by PL 90-483, 90th Congress, 2d Session, Flood Control Act of 1968. The Conveyance System was authorized for the purpose of conservation and conveyance of water supplies to ENP, and for expanding agricultural and urban needs. As a part of the Conveyance System necessary modifications to the C&SF Project were constructed upstream of L-31W (including improvement of the L-31N Borrow Canal upstream of its confluence with C-103) to enable adequate delivery of water to Taylor Slough and the Park's Eastern Panhandle. No canal improvements were made to L-31W or C-111 as a part of the conveyance system. However, S-332 was added as a part of the system to pump water deliveries to Taylor Slough from L-31W borrow canal. S-332 is operated to satisfy the minimum delivery requirements of Taylor Slough as specified in PL 91-282. In 1976, the specific operation of S-332 was agreed upon in an Agreement and Permit signed by the Corps, National Park Service and the C&SF Flood Control District (now

SFWMD). Although the total annual volume of 37,000 acre-feet to be delivered to Taylor Slough remained the same, the monthly distribution used in the agreement varied slightly from that prescribed in PL 91-282. The average monthly flows in cubic feet per second shown in Table 2-2 are the minimum pumping rates governing the operation of Pumping Station 332 and are subject to the availability of water in the system. During flood periods such rates may be exceeded, up to the capacity of the pumping station, upon mutual agreement of the National Park Service, the SFWMD, and the Corps of Engineers. Construction of S-332 was completed in 1980.

Table 2-2

Minimum Monthly Delivery Schedule At Taylor Slough

Month	Percent of Annual Flow	Monthly Flow Acre-Feet	Average Daily Flow Cubic Feet per Second
January	2.0	740	12.0
February	1.0	370	6.7
March	0.5	185	3.0
April	0.5	185	3.1
May	1.0	370	6.0
June	18.0	6,600	112.0
July	20.0	7,400	120.0
August	8.0	2,960	48.0
September	16.0	5,920	100.0
October	21.0	7,770	126.0
November	10.0	3,700	62.0
December	2.0	740	12.0
TOTAL	100.0	37,000	

The original operational plan for L-31W calls for leaving S-175 and S-176 closed during normal wet seasons to provide sufficient head for the discharge of water from L-31W into Taylor Slough. Provided that L-31N borrow canal could be maintained at 6.5 ft. under these conditions, 500 cfs capacity could be discharged from L-31W to the slough. However, under flood conditions when S-176 would be open, L-31N would be drawn down to elevation 6.0 ft. Since 500 cfs of flood flows were to be discharged via L-31W and since stages in the L-31W borrow canal would be about 5.2 ft. - at which stage only limited flows would pass to the slough - S-175 would be the major outlet for design flood flows. Consequently, S-175 was designed to provide up to 500 cfs capacity.

The area between L-31W and C-111 also known as the "Frog Pond" was considered to be included in the C-111 basin. Therefore, secondary drainage of this area (when constructed) would discharge into C-111, not the L-31W borrow canal. At this time only limited secondary drainage works have been constructed.

The Frog Pond consists of 5,200+ acres located between L-31W and C-111. A portion of the area, lying along the eastern edge adjacent to C-111 has been used for seasonal agriculture since the 1920's. Winter crops were planted after water naturally receded to acceptable levels. Prior to 1981, there were no water management manipulations of canals to lower water levels below their optimum levels to benefit agriculture in the Frog Pond. In 1981, following severe flooding associated with Tropical Storm Dennis, the SFWMD, ENP, and the farmers developed operating criteria that constituted the basis for water management in 1982 and 1983. These criteria called for maintaining a wet season stage of 4.5 ft. upstream of S-175 and S-177. During the dry season, supplemental water deliveries would be made as necessary to prevent these stages from falling below 3.0 ft., if sufficient water was available. There were no intentional lowering of canal stages for the benefit of agriculture. The criteria stated that after stages had receded naturally and tomatoes were planted, S-175 and S-177 discharges would be made following large rainfall events to alleviate flooding.

In 1984, farmers stated that market competition required earlier land preparation and planting in the Frog Pond. After a series of coordination meetings between the ENP and the farmers, an agreement was reached to conduct a one-year test to evaluate the impacts of the Frog Pond drawdown on Taylor Slough. The criteria called for L-31W and S-177 headwater stages to be lowered to 3.5 ft., NGVD by October 15. This stage was to be maintained in L-31W throughout the growing season. After the tomatoes were planted, the S-177 headwater was to be maintained at 3.7 ft. until crops were harvested. The Frog Pond drawdowns were conducted in 1984, and continued in 1985, and 1986.

During this same time, the Rain-Driven Water Deliveries to ENP test was being conducted. The congressionally mandated Experimental Program of Modified Water Deliveries to Everglades National Park (Public Law 98-181, Section 1302), passed by Congress in December 1983, authorized the Corps of Engineers, with the concurrence of the National Park Service and the South Florida Water Management District (SFWMD) to conduct an experimental program of water deliveries from the

Central and Southern Florida (C&SF) project. The Act further authorized the Secretary of the Army to acquire interest in lands currently in agricultural production and to construct necessary flood protection measures for homes impacted by any modification of the water delivery schedule to the Park. In the Conference Report (98-551) Congress stated that the change in water delivery could have an adverse impact on privately owned lands east of the Park and recognized the need to address and resolve this situation and treat fairly private land owners whose properties may be affected as a result of water delivery modifications necessary to protect ENP.

On July 12, 1985 an agreement was reached between the SFWMD and the Frog Pond farmers in response to the Kendall et. al. v. Marsh, et. al lawsuit. This agreement permitted the Water Delivery Experiment program to continue without further litigation by the farmers in exchange for lower canal levels during the growing season. In 1985 the Corps of Engineers performed an Environmental Assessment and filed a Finding Of No Significant Impact (FONSI) dated June 7, 1985 for the Experimental Program. On July 24, 1985 a Letter of Agreement between the Corps ENP, and SFWMD for the testing process was signed. To date there have been 6 Addenda to the original Letter of Agreement. Addendum 1 presented the operational procedures used in a 2-year test of the Rain-Driven plan for Water Deliveries to the ENP that ended on June 14, 1987. Addendum 2 prescribed operational procedures for the Rain-Driven Plan used through July 10, 1988. Addenda 3, 4, and 5 represent continuation of the operational procedures contained in Addendum 2. Section 107 of Public Law 102-104 authorized continuation of the Experimental Program of Water Deliveries to ENP until the modifications to the C&SF Project authorized under Section 104 of Public Law 102-229 are completed and implemented.

In June 1993, the U.S. Army Corps of Engineers, SFWMD, and ENP began another iteration of the Experimental Program known as the "Taylor Slough Demonstration Project". In addition to carrying on the Rain-Driven Water Deliveries to Shark River Slough, the Taylor Slough Demonstration Project increased L-31N Borrow Canal stage between S-331 and S-176 from 4.5 ft. to 5.0 ft. during the wet season. This was done to reduce seepage losses from Taylor Slough into the canals. In addition several portable diesel pumps were added to S-332 to bring the current pumping capacity to 465 cfs. Operating criteria for this test is contained in Addendum 6 of the Letters of Agreement. In November 1993, the Frog Pond farmers filed a complaint against the SFWMD and the Corps seeking a preliminary injunction to stop the test. The court denied this request and litigation is now proceeding in a routine manner. The farmers claimed that the higher water levels during the test are preventing them from preparing and planting their crops.

2.2.3 Water Deliveries to the Eastern Panhandle of ENP via C-111

The purpose of S-18C is to maintain desirable water levels in the upstream reach of Canal 111, pass flood flows up to 40 percent SPF without exceeding design stages upstream, and act as a control point for water deliveries to the Eastern Panhandle of ENP. Gate operations are remotely controlled to maintain an optimum range between 2.0 and 2.4 feet above the structure while making minimum monthly water releases for ENP as shown on Table 2-3.

Table 2-3

Minimum Monthly Delivery Schedule At Eastern Panhandle
(As delivered at S-18C)

Month	Acre-Feet	Month	Acre-Feet
January	1,540	July	510
February	630	August	860
March	290	September	2,690
April	110	October	4,630
May	110	November	4,060
June	340	December	2,230

The purpose of S-197 is to maintain optimum water control stages in the upstream section of Canal 111 to prevent saltwater intrusion. Most of the time S-197 is closed to promote discharges from S-18C to spill from the canal banks into the panhandle of the Everglades National Park. S-197 releases water only during major floods. During a flood event, the plan of operation was to remove the earthen plug and allow full canal flow. The plug would remain out of the canal until much of the upstream drainage basin had drained and it was possible to close S-18C and S-177. These structures had to be closed to stop high water velocities in the canal and enable replacement of the earthen plug. It has been necessary on 5 occasions to remove the S-197 plug. The large volumes of water that were discharged to Manatee Bay/Barnes Sound have caused substantial environmental damage associated with reduced salinity.

Attempts have been made to limit the need for S-197 discharges. Following a major S-197 discharge in 1988, SFWMD constructed 10 additional culverts in the S-197 plug adjacent to the existing 3 culverts. This has provided the operational flexibility to limit the total volume of S-197 discharges required during a storm.

Additionally, SFWMD has constructed a new culvert structure, G-211, in the L-31N borrow canal immediately south of its intersection with C-1. As a result, during the Experimental Program, there will be a reduction in the need for S-331 discharges. With G-211 in place, S-331 will only pump water levels in the canal immediately adjacent to the 8.5-square-mile area in order to drain groundwater from the area. Previously, S-331 had to pump water levels in the L-31N canal all the way upstream to U.S. Highway 41. However, as previously noted, the future "without project" condition does not include the Experimental Program.

2.2.4 Modified Water Deliveries General Design Memorandum (GDM)

The Everglades Protection and Expansion Act of 1989 authorized acquisition of approximately 107,600 of the East Everglades for incorporation into the park. This Act also authorized the construction of modifications to the Central and Southern Florida Project to improve water deliveries to the park and to the extent practicable permits steps to restore the natural hydrological conditions within the park. The GDM, approved in 1992, presents a structural plan that will allow adequate operational flexibility to satisfy environmental objectives without adversely impacting developed areas. These modifications are "justified by the environmental benefits to be derived by the Everglades ecosystem in general and the park in particular". The plan will also restore water flows through WCA No. 3B that would more closely match the pre-project conditions. Along with the C-111 plan, the structural features of the plan would enable enough operational flexibility to accomplish a wide range of operational strategies for meeting project objectives and environmental restoration.

Currently, the Corps of Engineers is implementing the Modified Water Deliveries to Everglades National Park plan. The proposed structural features will permit S-331 to return to its design purpose of providing water supply deliveries southward to Everglades National Park. The approved Modified Water Delivery plan provides flood mitigation to the residents of the 8-1/2-square-mile area by the addition of a seepage levee and canal and a pump station to prevent increased flooding in the area. If pending legislation is enacted, the 8 1/2-square-mile area would be acquired and the recommended structural features would not be constructed.

The purpose of S-331 is to function as a component of the conveyance canal system to Everglades National Park. The system is designed to provide supplemental water from Water Conservation Area No. 3A to satisfy peak dry season demands of ENP and south Dade County agricultural users during a 1-in-10 year drought. S-331 is required to lift water to obtain adequate hydraulic head in the L-31N borrow canal to enable the southward conveyance of water. S-331 would be operated as necessary when stages in the downstream conveyance canals recede 1.5 ft. below their design optimums.

However, concerns over increased water deliveries to Northeast Shark River Slough (NESRS) as a part of the Experimental Program prompted a change in the way S-331 is operated. For the Experimental Program, S-331 has been used to provide flood mitigation for the 8-1/2 square mile area. In the flood mitigation mode, discharge is performed in response to the stage at a groundwater monitoring well known as Angels Well. If the stage at Angels Well is below 6.0 ft. discharges through S-173 and, if necessary, S-331 will be made so as to maintain an average headwater of 5.0 ft. If the stage at Angels Well exceeds 6.0 ft., discharge is made to maintain an average headwater stage of 4.5 ft., until Angels Well drops to 5.7 ft., whereupon the S-331 headwater is allowed to rise to 5.0 ft. During any of these operations, the discharge of S-331 will be limited so as to not to cause downstream structures to exceed their design stages.

2.2.5 Salinity Intrusion

The Biscayne Aquifer underlies approximately 3,000 square miles of Dade, Broward, and southern Palm Beach Counties. It is a surficial, highly permeable, wedge-shaped aquifer that ranges from about 100-400 feet in depth along the coast and thins to a few feet thick near its western boundary 35 to 40 miles inland. This aquifer and other surficial aquifers in Palm Beach County provide water for municipal and industrial water supply and agricultural irrigation along the southeast coast. Seepage and water supply releases from the Water Conservation Areas recharge the surficial aquifers and prevent saltwater intrusion along the coast. The C&SF system is designed so that, except at coastal salinity structures, canal stages in general may be permitted to recede approximately 1.5 feet below the optimum levels before supplemental water must be introduced into the ENP-South Dade Conveyance System.

2.3 WATER QUALITY

Water quality has been a major concern in the Everglades for many years. Mercury and excess nutrients are the most frequently cited sources of concern. Elevated mercury levels have resulted in recommendations for restricted human consumption of fish from even the most remote portions of the area. There is a lack of agreement on the source of the mercury problem; however, oxidation of peat, agricultural chemicals, refuse incineration and contamination of regional airsheds are frequently mentioned.

The Everglades is a naturally low-nutrient system, and man-induced sources of nutrients result in changes in vegetation patterns and periphyton communities. Of primary concern in recent years has been the introduction of phosphorus through agricultural practices in the northern Everglades. The most visual result is the conversion of thousands of acres of native sawgrass communities to cattail communities. The recent die-off of vast areas of seagrass in Florida Bay and the persistence there of a very damaging algae bloom is considered by some to be a result of nutrient pollution.

Lawsuits, agreements, meditations, research legislation and a Surface Water Improvement and Management (SWIM) plan have forwarded philosophy that water entering the Everglades should be near natural background. Increasingly diligent efforts are being undertaken to reduce nutrient input, however, loading from the Everglades agricultural area remains far above natural background. Lower in the system, at the entry points of water into Everglades National Park, nutrient levels are mandated to be near natural background.

Natural background level for total phosphorous in the Everglades is less than 10 parts per billion (ppb). Criteria for total phosphorus input, computed on an annual flow weighted basis, at the S-12 structures are 9-14 ppb in 1997, and 8-13 ppb in 2002. At the S-332, S-175 and S-18C structures the input is mandated to be 8-13 ppb by 2002 (US vs SFWMD et al. Settlement Agreement 11 July 1991).

The levels of phosphorous input at the S-12 structures is expected to progressively decline as control procedures are implemented in the agricultural areas to the north. Phosphorous levels at S-332, S-175 and S-18C are low but have been increasing in recent years, and now frequently exceed target levels. This is believed to be a result of increasing agricultural use and changes in land use in the Taylor Slough Watershed.

2.4 ENVIRONMENTAL RESOURCES

The historic Everglades was a broad, shallow wetland flowing very slowly over 3,900 square miles from Lake Okeechobee to the mangrove zone at the southern tip of Florida. The source of water was rainfall; only in extremely wet years did water overflow from Lake Okeechobee into the Everglades (Leach, Klein and Hampton, 1972). In wet years, notable lateral discharge to the Atlantic Ocean occurred through the New River, the Miami River, and through the transverse glades across the coastal ridge. Thickly growing vegetation in the Everglades and the relatively small surface relief allowed only very slow rates of flow. Slow flow rates and high evapotranspiration rates probably prevented any water from Lake Okeechobee from reaching the Tamiami Trail, even in excessively wet years (ibid). The southeastern Everglades, therefore, were dependent for water upon local rainfall and that falling nearby to the north. High rainfall years produced elevated water levels, and low rainfall resulted in lowered water levels. Presently, water can be delivered to the southern glades from Lake Okeechobee via the Miami Canal and the L-67A canal, or water can flow overland as sheet flow through Water Conservation Area No. 3A and 3B.

2.4.1 Everglades National Park

Recognized by the U.S. Congress as a nationally and internationally significant resource (Everglades National Park Protection and Expansion Act of 1989), Everglades National Park (ENP) lies at the southern extremity of the Everglades and below the south end of the C&SF Project. ENP provides habitat for about 25 terrestrial species and two aquatic species of mammals. The avian fauna of the Park is especially rich; over 300 species of birds have been identified. South Florida's location makes it a migratory crossroads for West Indian and Central and South American birds; numerous North American species are residents. The majority of this continent's species of wading birds, shorebirds, and waterfowl are found within the Park at some time of the year. One of the key reasons for the establishment of the Park was to protect the nesting areas and feeding grounds of wading birds such as herons, egrets, and ibis.

The known herptiles of the region include 2 species of crocodilians, 3 or 4 species of salamanders, 6 species of lizards, 10 species of land and freshwater turtles, 5 species of sea turtles, 12 species of frogs, and 23 species of snakes. The waters of the Everglades and the Park support a large variety of fish in both freshwater and estuarine habitats. Fish provide a major part of the diet of most of the other vertebrate animal inhabitants.

2.4.2 Shark River Slough East and West Basins

Shark River Slough (SRS) is the southern, relatively deep, Everglades flow-way entering the Park from the north and flowing across the Park to Florida Bay. (The slough is east of the area of outflow from Big Cypress Swamp). The seasonal expansion and contraction of water supply to SRS provided the dynamic pulses of expanding aquatic flora and fauna to which responded the Everglades panoply of wading birds, bald eagles, alligators, and characteristic mammals.

Historically, SRS flowed between the present L-30--Tamiami Trail area and the 40-mile bend at L-28, and the volume and rate of flow occurred in response to rainfall. Annual water flow volumes varied through wet and dry years from essentially zero to 1,181,000 acre feet; the reported median was 311,201 acre feet (van V. Dunn, 1961). Fifty-eight percent entered Shark River Slough during September through November. About 66 percent of the average annual flow passed through the eastern one-half of the Slough (L-67A to L-30, i.e., Northeast Shark River Slough--NESRS), and the remainder entered western SRS between L-67A and L-28 (Leach, Klein, and Hampton, 1972). These proportions were changed after 1961 by water management practices following completion of L-29 and L-67A (Table 2-4).

Table 2-4
Changes in Flow Past the Tamiami Trail Culverts Before and After Construction of L-29 and L-67A
(after Leach, Klein, and Hampton, 1972)

Period of Record	Levee 30 to L-67A (Northeast Shark River Slough)	L-67A to L-28 (Western Shark River Slough)
1. 1941 - 1961	average 252,600 ac-ft/yr	average 128,900 ac-ft/yr
2. 1962 - 1968	average 63,200 ac-ft/yr	average 323,600 ac-ft/yr
3. Modified Rain Driven	average 384,000 ac-ft/yr	average 297,000 ac-ft/yr

Note: 1962 is after construction of L-29; water volume to NESRS by seepage, only.
Sources: Rows 1 and 2, Leach, Klein and Hampton, 1972; row 3, USACE, 1992.

Water management practices (prior to the SFWMD Interim Plan for C-111 Basin; paragraph 1.6.2) prevented any correlation between rainfall and water levels in Shark River Slough and Taylor Slough, except in extreme flood periods and drought periods (Van Lent and Johnson, 1993). Implementation of the Modified Water Deliveries to Everglades National Park could deliver 56 percent of average annual SRS flows through NESRS. Annual average flow through NESRS would be 384,000 acre-feet, while flow through the L-67A to L-28 reach would be about 297,000 acre-feet (USACE, 1992).

Environmentally beneficial hydroperiods (periods when water levels are at or above ground level) are interrelated in eastern and western Shark River Slough (SRS), the Rocky Glades, Taylor Slough (including the southeastern Frog Pond), and the western and eastern C-111 basins.

"(W)hen water levels over the (5.2 to 5.5 feet) peat surfaces of the Shark Slough (as measured at Well P-33 [in the center of the slough]) rise about one foot there begins an easterly flow of water into the microkarst, or pinnacle rock, terrain surrounding Taylor Slough. With a rise at P-33 to a level of 6.5 feet the Taylor Slough and Shark Slough surfaces become one across the tops of most of the intervening rock pinnacles and strong southerly flow is established through both systems. Early rainy season local recharge (i.e. April-June) will have normally elevated groundwater in Taylor Slough to or slightly above marl surface in lower elevations. This rise would have been augmented from June through November by strong southeasterly spill-over flow out of the Shark Slough. Thus, the hydroperiod duration of Taylor Slough normally would have extended from June through November, or about 7 months, and maximum depths would be expected to range from 3 or 4 inches in the northern shallowest ends of Taylor Slough headwater areas to about 20 inches near the Park entrance" (TBI, 1990).

Critical to Taylor Slough--C-111 environmental restoration is restoration of the seasonal overflow of water from SRS. Under the Modified Rain Driven Plan proposed for delivery of water to ENP (USACE, 1992), the overflow stage of 6.5 feet in SRS at P-33 would occur during 12 years of the 14-year period of record (1969-1982). The stage at P-33 reached 6.5 feet in 12 years of the 14 under without modified deliveries, but seasonal timing and durations differed. Under the Modified Rain Driven Plan, the overflow stage of 6.5 feet at P-33 in Shark River Slough would be exceeded about 25 percent of the time, with smooth within-season transitions between wet and dry conditions. Before the interim plan (par. 1.6.1), P-33 water levels were at or above 6.5 feet only 15 percent of the time, and water levels were subject to erratic pulsations. Alternatives 4, 6, and 6A of this study raise water levels in Shark Slough. The cumulative effect, under adequate water supply and judicious water management, may be similar to that of the natural overflow.

The rising water pattern historically has generated southeasterly flow of groundwater through the porous, oolitic, limestone ridge east of Taylor Slough. As groundwater passes through it, the limestone dissolves and is entrained in the water as calcium carbonate. When the calcium carbonate-saturated water issues from the ground at lower elevations along the coastal plain, periphyton extracts and precipitates calcium carbonate as marl. In the coastal plain, "there is no sign that surface flows were ever significant in quantity due to the extreme porosity of the oolite" (TBI, 1990).

2.4.3 The Rocky Glades

Rocky glades is a term for a wet, transitional area between deep peat or marl wetlands and seldom flooded uplands. In the study area the term is applied to the slight topographic rise north of Taylor Slough and south and east of Shark River Slough. The Rocky Glades is a hydrologic barrier that separates surface waters of Shark River Slough on the north from the headwaters of Taylor Slough on the south (SFWMD, 1992). Ground elevation is generally higher than in the wetlands, and hydroperiods, depending on ground elevation, range from 6 months to less than 1 month (Robertson and Frederick, 1994).

Original rocky glades vegetation included plant associations adapted to an environment of alternating, seasonal periods of shallow flooding and desiccation. Fires presumably occurred only during the driest years. Vegetative communities are dominated by sedges or grasslike plants in fairly thin, short stands, interspersed with patches of exposed limestone rock or limy mud (SFWMD, 1992). Dominant types include sparse sawgrass (Cladium jamaicense), spikerush (Eleocharis cellulosa), and beakrush (Rhynchospora spp.) meadows, in association with muhly grass (Muhlenbergia sp.) prairies. Associated broadleafed species, locally called "flags," include arrowheads and water hyssop (Sagittaria and Bacopa spp.) Sawgrass growing over marl tends to form a thin and open cover type, in contrast to the dense, tall sawgrass meadows of the deeper water areas of Shark River Slough. The rocky glades may provide significant feeding habitat to widely ranging wading birds as water recedes and small fish and invertebrates are trapped in drying pools.

In the C-111 study area, the Rocky Glades on the upland periphery are farmed or used for homesites. The 8.5-square-mile area is in the Rocky Glades

2.4.4 Taylor Slough

Headwaters of Taylor Slough provide the main inflow to eastern Everglades National Park. Its headwaters begin in the southern East Everglades below the Rocky Glades and include the southeastern portion of the Frog Pond. The Slough extends more than 20 miles to the coastal mangrove fringe along Florida Bay (SFWMD, 1992). Under natural conditions, Taylor Slough is the major source of fresh water flow into northeast Florida Bay. A significant portion of the annual flow of water in Taylor Slough is related to hydrological events in Shark River Slough (Section 2.4.2)

2.4.5 The Frog Pond

The agricultural area east of L-31W is farmed with the technique called rock plowing. The limestone rock is broken, pulverized, fertilized, and cultivated to grow food crops, mainly tomatoes. About 20 percent of the frog pond is too low (i.e., too wet) for cultivation. Of the higher, cultivated portion, much of the land in the Frog Pond agricultural area originally supported South Florida slash pine (Pinus elliotii *var.* densa) stands. The effect of rock plowing is to even out the topography over large areas. The tops of the rocky pinelands are scraped off and most of the lower areas are filled. The artificial "soil" created by the practice of rock plowing and fertilization apparently is inhospitable to most native plant species, even many years after agricultural abandonment, when virtually nothing but solid stands of Brazilian pepper (Schinus terebinthifolius) will colonize. As wildlife habitat, abandoned rockplowed uplands are of little value.

A few relict wet "tree islands" remain undisturbed within about 389 acres inside the Frog Pond Agricultural area, protected by legal covenants with Dade County (FWS, 1991). When surveyed by FWS in early 1991, these wet hammocks were dominated by red bay (Persea borbonia), sweet bay (Magnolia virginiana), wax myrtle (Myrica cerifera), cabbage palm (Sabal palmetto) strangler fig (Ficus aurea), cocoplum (Chrysobalanus icaco), and the invasive exotic Brazilian pepper (Schinus terebinthifolius). Tree hammocks, wet or dry, are significant wildlife habitat, providing refuge from ground-based predators and from the heating and drying effects of the sun.

2.4.6 The Marl Glades

Of the two main types of Everglades wetlands soils (peat and marl) only marl soils occur in the C-111 study area. Marl forms only under intermittent shallow surface flooding conditions in carbonate-saturated water. In south Florida, marl formed adjacent to large exposures of soft limestone, such as the Miami oolite, under alternating wet and dry seasons of about equal length, when blue-green algal mats on the rock surface and on plant stems precipitated calcium carbonate crystals from the carbonate-rich surface water. Over geologic time the carbonate accumulated along with organic plant remains to form marl soil. The specific set of hydrologic conditions in which the southeast Everglades marl formed (TBI, 1990) are taken to indicate desirable water regimes for wetland ecosystem restoration, and to assist in selecting the environmental quality plan from among alternatives (Section 6). Studies indicate that a relatively short hydroperiod (5-7 months), water depths ranging from 3 to 21 inches, and a water table that seldom drops more than 30 inches below the soil surface are required to support marl-forming wetlands (TBI 1990).

The original wetlands plant associations of the area are similar to those described under rocky glades or wet prairie. Hydroperiods now are generally shorter, flooding is less deep, and fires more frequent, than prior to human alteration of drainage. Shorter recent hydroperiods have favored the expansion of shrub communities, including native willow (Salix caroliniana), red bay, dahoon holly (Ilex cassine) and the exotics Brazilian pepper and melaleuca (Melaleuca quinquenervia). Cattails (Typha domingensis) have become more prominent in some areas where agricultural drainage contributes to surface flows. Wet prairies, including the marl glades, are habitat for a distinctive assemblage of native fish during the wet season. When the prairies dry out in winter months, fish populations are concentrated in pot-holes or ponds, or emigrate towards the deeper, central Everglades, attracting large numbers of fish-eating resident and migrant wading birds, including the endangered wood stork. As desiccation continues, fish stocks survive in pot-holes and sinkholes in the porous limestone. If the wet prairie hydroperiod is reduced too much, or too little water is delivered, the ground water table will sink below -30 inches, and even the pot holes and remnant ponds will dry out. When this occurs, no fish stocks may be available to repopulate the flooded prairie during the next wet season.

2.4.7 Florida Bay

Florida Bay is the large, shallow, coastal lagoon lying between the southern tip of the mainland of Florida and the Florida Keys. It is of great national significance for several reasons. Florida Bay, the nearby terrestrial and wetland environments of southern Florida, and the Florida Keys and associated coral reefs together constitute the only tropical environments in the continental United States. Essentially the entire Bay is under direct management responsibility of the Federal Government, either as part of the Everglades National Park managed by the National Park Service, or as part of the Florida Keys National Marine Sanctuary managed by the National Oceanic and Atmospheric Administration. This ecosystem harbors various threatened or endangered plants, fishes, birds, mammals and reptiles and supports a major sport and commercial fishery.

Florida Bay is a dynamic ecosystem and has undergone great natural variation over the past thousands of years due to long-term changes in climate and sea level and, during this century, as a result of climatic cycles and storms. Substantial disturbance, both from hurricanes and variations in freshwater inflow, is, in fact a natural part of the ecology of Florida Bay. However, the changes that have been observed in Florida Bay from at least the late 1980s have been unprecedented within the period of recorded observation and reflect a degradation of the ecosystem in terms of its productivity of living resources, biodiversity, and stability.

Beginning about 1987, seagrasses, large vascular plants rooted in bottom sediments which carpet the bottom of most of the Bay, began to die. This die-off continues and has now affected an area as large as 100,000 acres (40,000 hectares or about 18 percent of the total area of the Bay. Blooms of microscopic algae suspended in the water have occurred with increasing frequency, intensity, extent, and duration, turning the once-clear waters a turbid green. Populations of water birds, forage fish, and juveniles of game fish species seem to have been significantly reduced in the eastern portions of the Bay where fresh water flowing from the Everglades is normally mixed with saline Bay water. Catches off the Tortugas of pink shrimp, which spend their early life in Florida Bay and other shallow water regions, have declined dramatically. Many large sponges attached to the Bay bottom died, potentially threatening a significant decline in the catch of spiny lobsters, the juveniles of which use the sponges as critical habitat.

Several scientists and other observers have argued that most of these changes are related, one causing another, and have as a root cause changes in the freshwater flow--both its quantity and timing--through the Everglades into Florida Bay. Other scientists have suggested that the changes may be manifestations of natural cycles, including the frequency of hurricanes; may be related to filling in and development of the Florida Keys; or are caused by greater infusion of plant nutrients, particularly forms of nitrogen and phosphorous, from the watershed.

The most likely explanation for the changes observed in the Bay is that several impacts are working synergistically to produce a much more profound result than that which might be expected from individual insults to the system. Restoration of a more natural hydrology will correct one of the major problems in the Bay. It is not known whether this alone will restore Florida Bay, but it is unlikely that restoration will occur without the natural fresh water increment from the Everglades.

2.4.8 Barnes Sound

Barnes Sound, at the northeastern end of Florida Bay (see Figure 1-2), receives the outflow from C-111 through Manatee Bay when the culverts at S-197 are opened for flood damage control following major storm events. SFWMD (1992) summarizes information on Manatee Bay and Barnes Sound, emphasizing the geological distinction between these sounds and the rest of Florida Bay. These are completely enclosed hydrographic basins dependent on local climatological factors (rainfall and canal discharge rates). Circulation is wind and tide driven except when fresh water inflow influences circulation. Historically, salinity concentrations rose as the need for fresh water increased during the dry season. The massive displacement of fresh water southward, discussed in Section 2.4.2 of this report, helped maintain the fresh water-salt water balance. Reduced fresh water flow under present conditions presumably exacerbates the tendency toward hypersalinity, and flood releases prior to installation of the culverts at S-197 caused fresh water to flow over the denser, saline water of Manatee Bay. Seagrass die-offs in the Bay have been speculatively linked to such flood releases, but there appear to be other, unknown factors at work (Boesch et al., 1993).

2.4.9 Coastal Mangrove Fringe

Vegetation of the lowermost C-111 basin is estuarine: it is influenced by tidal flooding, saline ground water or occasional salt deposition during storms. As one moves southward and eastward down the canal, south of the agricultural area, the wet prairies grade into mangrove swamps. Mangroves are salt-tolerant trees, reaching heights of up to 30 feet in the study area, that can survive permanent or intermittent flooding, but cannot tolerate desiccation. Many fresh water emergent marsh species (including sawgrass and cattail) can tolerate low dissolved salt concentrations (below about 0.5%), but die if salinity increases or persists throughout the growing season. Mangroves can grow in fresh water, but are believed to dominate only where salinity is high enough to stress fresh water vegetation and reduce its competitive advantage. Because of these overlapping tolerances, the transition zone or ecotone from fresh water associations to brackish water associations in the Everglades is broad. Historic reduction of freshwater recharge into the lower C-111 marshes is believed to have played a role in fostering salinization of shallow groundwater and northward expansion of the estuarine, or mangrove zone. Mangroves first appear at the inland edge of the brackish marshes, in association with sawgrass and black needle rush (Juncus roemerianus), as isolated individuals or small tree islands. Usually these pioneer hammocks are made up of red mangrove, Rhizophora mangle, or white mangrove (Laguncularia racemosa). In low salinity areas where drying is frequent, buttonwood mangrove (Conocarpus erectus) dominates. The isolated hammocks eventually coalesce into a wide band of red, black (Avicennia germinans) or mixed mangroves.

Mangrove islands and the mangrove fringe that lines Florida Bay are extremely valuable wildlife and fish habitat. Small fish are generally abundant. Herons, egrets, and other wading birds use mangrove habitats for both feeding and nesting habitat. Especially during dry years, mangrove nesting habitat may be critical to maintain populations of herons, ibis and wood storks unable to nest in freshwater habitats. Raptors, including the bald eagle, osprey and migrant peregrine falcon, use the mangrove fringes as nesting or roosting habitat. Mangroves support estuarine fisheries through export of both particulate and dissolved organic matter, and serve as spawning grounds or nursery areas for almost all of the commercially significant salt water fish species harvested around south Florida (W.E. Odum et al 1982).

2.4.10 Fauna

Fauna characteristic of the C-111--Taylor Slough basin range widely over all the recognized drainage sub-basins and vegetation communities. The entire basin may be thought of as a diverse habitat, with its various parts used seasonally by wide-ranging prey and predators. Faunal groups of the study area are discussed below.

2.4.10.1 Fish

Fishes of the East Everglades-C-111 basin are small to medium-sized. Flagfish (Jordanella floridae) and the mosquito fish (Gambusia affinis) comprise the largest portion of recent samples taken by the SFWMD (SFWMD, 1992). Thirty-nine other species were identified, including killifish, topminnows, bullhead catfish, several species of sunfish, including largemouth bass, and exotic cichlids.

The fish community is limited by hydroperiod. A reservoir of breeding fish is required to seasonally colonize the short-period wetlands of the study area. In periods when surface water is maintained without interruption from year to year, as may happen occasionally in Taylor Slough, fishes may increase in density and biomass. As the wetlands dry, fish unable to find refuge in Taylor Slough become concentrated in pools and are preyed upon by foraging birds. Extremely dry conditions and rapid drying rates result in high densities of fish concentrated in refuge pools where the fish subsequently become prey, or they become carrion after dissolved oxygen is depleted.

Estuarine fishes occur in higher numbers and biomass during the dry season in the mainland estuary in the lower C-111 basin when relatively deeper flooding occurs during the September-October time period (ENP data, unpublished).

2.4.10.2 Birds

Birds are arguably the most conspicuous and publicly recognized wildlife resource of the Everglades ecosystem. The avifauna of South Florida includes nearly 400 species, about 40% of them year-round residents and the rest migratory. However, migratory and resident wading birds are the resource of greatest concern in the present study, since they both depend upon and can serve as indicators of the environmental quality of the C-111--Taylor Slough wetlands. The extensive use of the C-111 basin by migrant wading birds as forage habitat was summarized by SFWMD (1992). A combination of short- and long-hydroperiod marshes and sloughs provide excellent foraging habitat for wading birds. The annual cycle of fish production begins when, in response to early-season rains, flooding extends out from the permanent sloughs into the wet prairie. Fish populations increase rapidly. As the rainy season ends, evaporation of standing water reduces the flooded area, and fish are concentrated along the drying edges of prairies, or in potholes and ponds, where they become easy prey for foraging waders, including the endangered wood stork. Wading birds generally nest in colonies in forested swamps, freshwater marsh tree islands or in coastal mangroves, but successful reproduction depends upon finding sufficient food resources, at the appropriate season, to allow nesting, egg-laying, and fledgling of young, which require large energy inputs. Significant numbers of the following wading birds still utilize the sloughs and wet prairies near C-111 during wet years: the endangered wood stork (Mycteria americana), white ibis (Eudocimus albus), great egret (Casmerodius albus), cattle egret (Bubulcus ibis, glossy ibis (Plegadis falcinellus), and the black-necked stilt (Himantopus mexicanus) (FWS, 1991).

In 1969-1970, coincidentally with a drop in water level in the northern part of Taylor Slough, abrupt changes is timing of nest initiation occurred in wood stork colonies; ENP reported that the change adversely affected nesting success. From 1981 to 1993, Cape Sable sparrow nesting attempts declined by 75 percent; sparrow habitat had been invaded by woody vegetation. Roseate spoonbill colonies have diminished since the early 1980s.

2.4.10.3 Mammals

Mammals known or potentially found in the study area include the Florida panther (Felis concolor coryi), river otter (Lutra canadensis), oppossum (Didelphis virginiana, marsh rabbit (Sylvilagus palustris) racoon (Procyon lotor), striped skunk (Mephitis, bobcat (Lynx rufus), white-tailed deer (Odocoileus virginianus), round-tailed muskrat (Neofiber alleni) and less conspicuous small terrestrial mammals such as weasel, voles, shrews, mice and rats, and several species of bats. Florida manatee (Trichechus manatus) occur in coast reaches of canals, mangrove tidal creeks and Florida Bay. The panther and the manatee are listed as endangered. Scrub thickets, tree islands, and remnant pine groves provide the only adequate cover for larger terrestrial mammals in the rockplowed agricultural areas.

2.4.10.4 Reptiles

Notable reptiles include the endangered American crocodile (Crocodylus acutus) and the American alligator (Alligator mississippiensis). The alligator is discussed in Section 6.4. American crocodiles range from southern Biscayne Bay south and west through eastern and central Florida Bay, including Manatee Bay and Barnes Sound. Nesting sites are on small sand beaches at the edge of hardwood thickets and on high marl banks of coastal creeks (Pritchard, 1978). Reasons for the population not increasing have been listed as (1) accidents and poaching in the Key Largo area, (2) hatching failure of eggs, and (3) low nest temperatures in shaded areas (Ogden, 1978a,b). Heavy metal burdens in crocodile eggs have been reported (Stoneburner and Kushlan, 1984, Ogden et al., 1974). Crocodile sensitivity to heavy metals is not known.

2.4.10.5 Threatened or Endangered Species

Endangered bird species that may be in the area include the Cape Sable seaside sparrow (Ammodramus maritimus mirabilis), snail kite (Rostrhamus sociabilis plumbeus), wood stork (Mycteria americana), and bald eagle (Haliaeetus leucocephalus). Federally listed reptile species include the American alligator (Alligator mississippiensis; listed as Threatened due to similarity in appearance to the American crocodile); the endangered American crocodile (Crocodylus acutus) and the endangered eastern indigo snake (Drymarchon corais couperi). The southern part of C-111 is within Critical Habitat for the endangered American crocodile (Crocodylus acutus), and two of the three known breeding areas border this region. Listed mammals include the endangered Florida panther (Felis concolor coryi) and the West Indian Manatee (Trichechus manatus). No panthers are known to be present in the C-111/Taylor Slough area. Manatees are observed in mangrove tidal creeks and Florida Bay near the southern end of C-111. The roseate spoonbill (Ajaia ajaja), while not federally listed, is a Florida State Species of Special concern (SSC) that utilizes wet prairies seasonally.

2.5 POPULATION

The 1990 census reports that Dade County, covering 1,955 square miles is the third largest county in land area in the State and ranks first in population with over 1.9 million residents for the 1990 census year. The county also ranks third for population density. In 1980, persons per square mile were 908. 1990 census reports an increase of approximately 83 more persons (991) per square mile. OBERs 1990 population projections for Dade County reports an increase in population of approximately 243,906 persons between 1990 and 2010. This will represent an annual growth rate of 0.6 percent. The median age for Dade County is 34.2 years.

2.5.1 Homestead

The 1990 permanent population for Homestead was 26,866. Between 1980 and 1990, the city's population increased by 6,198 residents. The median age in 1990 was 28.2 years, indicating a relatively young populace.

2.5.2 Florida City

The 1990 permanent population for Florida City was 5,808. Between 1980 (population was then 6,174) and 1990, the city's population decreased by 366 residents. The median age in 1990 was 26.5 years, also indicating a relatively young populace.

2.6 PERSONAL INCOME

Total personal income for Dade County in 1989 was approximately $33 billion, the largest among all Florida's Counties, which represents an average annual increase of 8.4 percent during the 1979-1989 period. Per capita personal income rose from $9,272 to $17,963, a 6.8 percent average annual gain. The median household income for Dade County in 1990 was $26,909. There were 341,261 persons for whom poverty status was determined in 1990. This represents 17.6 percent of the county's 1990 population with earnings below the established U.S. poverty level of $12,675.

2.6.1 Homestead

The median household income for the City of Homestead was $20,594. There were 7,843 persons for whom poverty status was determined in 1990. This represented 29.2 percent of Homestead's 1990 population with earnings below the established U.S. poverty level of $12,675.

2.6.2 Florida City

The median household income for Florida City was $15,917. There were 2,131 persons for whom poverty status was determined in 1990. This represented 36.7 percent of Florida City's 1990 population with earnings below the established U.S. poverty level of $12,695.

2.7 LABOR FORCE

Dade County's labor force totaled 1,519,969 persons 16 years of age or older in 1990. Total employed was 982,191, which represented a 64.6 percent participation rate for all persons in this broad age category. Government workers (116,428) represented about 11.9 percent of civilian employment. The unemployment rate was 7.7. percent.

2.7.1 Homestead

The total civilian labor force in Homestead, 16 years and older, was 19,222 in 1990. Total employed was 12,413, which is about 64.6 percent of the civilian labor force. Government workers (1,693) represented about 13.6 percent of civilian employment. The unemployment rate was 7.3 percent.

2.7.2 Florida City

The total civilian labor force in Florida City, 16 years and older, was 3,842 in 1990. Total employed was 2,355, which is about 61.3 percent of the civilian labor force. Government workers (443) represented about 18.8 percent of civilian employment. The unemployment rate was 16.4 percent.

2.8 CLIMATE

General climatic conditions along the Lower East Coast of Florida to the Florida Keys are sub-tropical to tropical. The chief factors of climatic control are latitude, proximity to the Atlantic Ocean and Gulf of Mexico, and numerous inland lakes. Summers are long, warm, and relatively humid. Winters, although punctuated with periodic invasions of cool to occasionally cold air from the north, are mild because of the southern latitude and relatively warm adjacent ocean waters. The Gulf Stream, which flows around the western tip of Cuba through the Straits of Florida and northward along the lower east coast, exerts a warming influence to the southern east coast largely because the predominant wind direction is from the east. Coastal weather stations throughout the State average slightly warmer in winter and cooler in summer than do inland weather stations at the same latitude. South Florida receives the highest percentage of possible sunshine of any part of the United States east of the Great Plains. Winter sunshine is especially high in comparison to other areas, being about 65-percent of possible in January. The high sunshine level results in extremely moderate temperatures, with conditions favorable for plant growth during winter and spring months. This has made year-round agriculture possible, particularly truck crops.

2.8.1 Temperature

Mean annual temperatures in the lower east coast area range in the mid 70's with January and February being the coolest months and July and August the warmest. There is about a 20 Fahrenheit degree average temperature range during the year with the temperature averaging in the mid-60's during the winter and the mid-80's during the summer. The summer heat is tempered by sea breezes along the coast and by frequent afternoon or early evening thunderstorms in all areas. During the warm season, sea breezes are felt almost daily within several miles of the coast and occasionally 20 to 30 miles inland. Thundershowers, which on the average occur about one-half of the days in summer, frequently are accompanied by as much as a rapid 10-20 degree drop in temperature, resulting in comfortable weather for the remainder of the day. Gentle breezes occur almost daily in all areas and serve to mitigate further the oppressiveness that would otherwise accompany the prevailing summer temperature and humidity conditions. Because most of the large-scale wind patterns affecting Florida have passed over water surfaces, hot drying winds seldom occur. Table 2-5 contains the average temperatures for NOAA stations along the lower east coast.

2.8.2 Rainfall

Although Florida enjoys abundant rainfall, a distinct wet season occurs between May and October. The wet season receives approximately 75 percent of the annual rainfall of 60 inches. In general, the winter months constitute the dry season and rainfall is associated with mid-latitude systems (fronts and low pressure centers) and is spatially distributed in a relatively uniform pattern. The summer months comprise the wet season and rainfall is closely associated with convective activity. These rainfall events are normally of short duration and amounts are quite variable spatially. During the summer there is about a 50 percent chance that measurable rain will fall on a given day. Much of the volume of summer rainfall occurs on a few disturbed days when the rain is more uniformly distributed. Even in the wet season, much of the seasonal rainfall variation over peninsular Florida is due to the large-scale regional and synoptic flow patterns affecting the sea-breeze and other local conditions.

Even though annual average rainfall is relatively large in the dry season well defined, rainfall over the basin can be quite varied both in annual amount and seasonal distribution. Table 2-5 contains precipitation data for NOAA stations along the lower east coast. Eight typical rainfall producing patterns have been identified over Florida.

(1) Isolated air mass. Local convective showers due to daytime heating. Generally, if rain occurs it is limited to a small area and short duration.

(2) Sea Breeze. Sea breeze generally occurs on undisturbed days during the warm months. Associated showers form along the coast and move inland during the day. There are many types of disturbance including cold air aloft and weak cyclonic flow.

(3) Sea Breeze and Disturbances. If sea breeze is associated with a larger scale disturbed pattern, more widespread rain is possible.

Table 2-5

Representative Climatological Stations

Stations	Normal Precipitation (inches)	Temperatures (F°)		
		Average January	Annual Mean	Average July
Miami (Dade)	46.29	69.1	76.2	82.3
Miami WSCMO Airport (Dade)	59.76	66.9	75.1	81.3
Miami (12 mi. SSW)	57.48	66.5	74.8	81.6
Homestead Experimental Sta	64.69	65.9	73.7	80.2

* Data from National Oceanographic and Atmospheric Administration (NOAA) stations.

(4) Meso-scale Thunderstorms and Showers. These systems area often perturbations along old frontal troughs. Meso-scale shower and thunderstorms are quite common over Florida in the summer months, usually due to cold air aloft.

(5) Squall Lines. Not common in Florida, lines of thunderstorms are sometimes along a cold front and act like a squall line.

(6) Warm and Cold Fronts. Frontal passages normally occur in the winter months. Frontal passages do not guarantee rain. During the summer months it is more common to have weak frontal zones that act as convergence zones and have few of the characteristic of winter fronts.

(7) Tropical and Sub-tropical Cyclones. A significant portion of wet season rainfall is associated with tropical systems. The amount of rainfall is not necessarily related to strength or classical structure of the system. Hurricanes and tropical storms account for some wet season rainfall. Tropical cyclones consist of tropical waves, tropical depressions, tropical storms, and hurricanes. See section 2.6.5 for more information.

(8) Stationary Upper Level Low Pressure Systems. Truly stationary upper level low pressure systems are rare. Over Florida, these systems are usually found in June, September, or early October. Upper level low pressure systems combined with a front can produce heavy, sustained rain over a widespread area. Large rainfalls in the dry season are usually due to these systems.

2.8.3 Evapotranspiration

Evapotranspiration accounts for the major portion of rainfall loss and its evaluation is necessary in order to determine the amount of rainfall excess available for other purposes. Total losses from land areas depend on both losses from vegetation (transpiration) and losses from saturated ground and open-water areas (evaporation). Climatic influences on evapotranspiration (ET) include radiation, temperature, humidity, and wind. The losses from evaporation pans and open-water areas are fairly uniform due to continuous supply of water. Losses from land areas may vary widely because of the greater variations in the amount of water available for ET. In a report entitled "Report of Runoff Investigations in Certain Florida East Coast Drainage Districts" determined that evapotranspiration losses increase at a diminishing rate when rainfall exceeds the normal evapotranspiration requirements. During dry periods, transpiration is limited by the moisture available in the root zone, and evaporation from the soil is limited to moisture brought to the surface by capillary action. In the Lower East Coast area evapotranspiration losses are estimated to be about 88 percent of the total rainfall over the area.

2.8.4 Wind

Prevailing winds over the southern peninsula are southeast and east. Wind directions are influenced locally by convectional forces inland and by the land-and-sea breeze-effect near the coast. Consequently, prevailing directions are somewhat erratic, but, in general, follow a pattern from the north in winter and from the south in summer. The windiest months are March and April. High local winds of short duration occur occasionally in connection with thunderstorms in summer and with cold fronts moving across the State in other seasons.

2.8.5 Tropical Cyclones

The most severe floods in the area are usually associated with storms or sequences of storms which produce widespread rainfall of one week to several months duration. June through October is the most probable period for heavy rainfall, but floods may occur during other times of the year. Stationary low pressure systems combined with fronts, and tropical and subtropical cyclones are systems capable of producing large amounts of rain over widespread areas. The region is subject to tropical cyclones from June through November. NOAA classifies tropical cyclones as follows:

(1) Tropical Disturbance: rotary circulation slight or absent at surface but sometimes better developed aloft: no closed isobars and no strong winds; also known as a tropical wave or easterly wave.

(2) Tropical Depression: one or more closed isobars and some rotary circulation at the surface, highest wind speed 39 m.p.h.

(3) Tropical Storm: closed isobars, distinct rotary circulation, wind speed 39 to 73 m.p.h.

(4) Hurricane: closed isobars, strong and very pronounced rotary circulation, wind speed 74 m.p.h. or greater.

2.9 STORMS AND FLOODS

The wet season in peninsular Florida normally begins in May and continues through October. During the summer months thunderstorms are common and are a result of small isolated cells directed by low-intensity pressure gradients. Most Florida localities have, at one time or another, experienced 2-hour rainfalls in excess of 3 inches and 24-hour amounts of near or greater than 10 inches. Nearly all localities have had within a single month from one-third to one-half as much rain as will fall during an entire average year. Occasionally, tropical storms or hurricanes produce copious rainfall over relatively large areas. Rainfall of over 20 inches in 24 hours is not uncommon within tropical storms or hurricanes, however, the average hurricane rainfall in Florida usually does not exceed 6 to 8 inches in a 24-hour period.

2.9.1 Floods of 1871 and 1898 - Greater Miami Area

These floods in the Greater Miami area were equal to or greater than the floods of 1929 and 1947, but detailed records of these earlier floods are not available.

2.9.2 Floods of 1926 and 1928 - Greater Miami Area

Exceptionally severe flooding occurred during 1926 and 1928. No reliable estimate of flood damages was made of the 1928 flood, which apparently exceeded the 1947 flood in depth, area of inundation and duration. During that flood, a maximum stage of 8.4 feet was observed at Hialeah, and flood waters were on low-lying areas for 105 days.

2.9.3 Flood of 1947 - Greater Miami Area

A comprehensive survey of damages sustained in the area followed the flood of September and October 1947. A large portion of the area experienced depths of flooding of 4 feet. Because several months passed before flood-waters completely subsided, damages to agriculture, residential property and highways was extensive. In addition to direct rainfall, flooding in 1947 was aggravated by inflows of large magnitude from the Everglades which resulted from breaks in the Dade-Broward and Golden Glades levees.

2.9.4 Floods of 1948, 1952 and 1953 - Greater Miami Area

Since local levees had been repaired prior to occurrence of these three floods, only seepage water entered the Greater Miami area from the Everglades. Flooding resulted from accumulated rainfall and lack of adequate drainage facilities. By 1952, L-30 and L-31 had been constructed, thus affording increased protection of the coastal area. The 1948 flood was the most severe of these three, but it was lesser in degree than the 1947 flood both in rainfall intensity and antecedent storage accumulation. Although the 1952 and 1953 floods were comparatively minor, considerable damage resulted since recent development had greatly increased the damage possibilities.

2.9.5 1960 Flood

September 1960 was one of the wettest months within the history of the Central and Southern Florida Flood Control District. The major causes were rainfalls resulting from hurricane Donna and the effects of tropical storm Florence. This rainfall created extensive flooding throughout much of the area. Approximately 20 to 40 inches of rainfall occurred over the greater portion of central and southern Florida for the period 21 July to 30 September.

2.9.6 Tropical Storm Dennis, August 16-18 1981

Areas affected by Tropical Storm Dennis include S-20, S-22, S-28, Florida City, Homestead, and South Miami. The Homestead and Florida City area reported 20 inches or more of rainfall, and the S-28 gage registered 18.82 inches. Rainfall in the area of Florida City and Homestead slightly exceeded the 1 in 100-year return frequency. Prior to the storm, the east coast had received abnormally low rainfall and regional water storage levels were low. Due to low water levels in the WCA's and the lack of normal wet season rainfall prior to the storm, canals stages were being maintained somewhat above optimum, to conserve water and to prevent further salt water intrusion. No controllable discharges were being made to tide water and all east coast salinity control structures were closed. Storm data show that for the most critical structures, peak stages occurred (generally 12 or more hours) after the structures were opened. Peak stages were sufficient to bypass the ridge and divide structures and were a result of rainfall quantities exceeding design by a large margin. The rainfall quantities associated with the storm greatly exceeded the quantities of water that the system was designed to accommodate. Design discharges were exceeded at all control structures, as were design stages. Isolated flooding occurred in Palm Beach and Broward Counties, with Dade County experiencing heavy flooding in many areas. In some areas, SPF stages and discharges were exceeded. The capacity of the south Dade facilities to remove runoff was greatly exceeded by the rainfall and associated runoff. Design rainfall amounts, structure discharge rates, and stages were exceeded without system failure. The system was operated and performed as designed.

2.9.7 Storm of April 23-24, 1982

The torrential rainstorm that occurred during April 23-24, 1982 was the second heavy rainstorm within a month that flooded houses and mobile homes, forced the closing of streets, and caused electric power loss in thousands of homes in the lower east coast area. Maximum rainfalls of 15.82 inches were reported in Dade County. Rainfall in the greater Miami area, including Miami, Miami Springs, Hialeah, areas between Hialeah Gardens and Sweetwater west of Miami International Airport, and Coral Gables, had a recurrence interval of between 5 and 10 years. Rainfall in the area south of Sweetwater and the area west of south Miami had a recurrence interval of between 25 and 50 years. The torrential rainstorm was the result of a warm front moving from Straits of Florida at 10 mph, in conjunction with a very large high pressure system located off the Carolinas. Flood waters had receded from most of the flooded areas in the morning of April 25, 1982. The flooding in several areas was worse than that caused by March's storm even though the total rainfall was less. This was due to the most intensive rain occurring in a rather short time, and the fact that many secondary and tertiary drainage systems had not been cleaned out after the March 28,29, 1982 storm and were clogged with debris and sedimentation.

2.9.8 Storms of June 1988

A succession of heavy rainfall events in south Dade County created local flooding in rural areas around Homestead during June. Pump station S-331 located along L-31N, recorded 16.8 inches of precipitation during the month. The lack of an adequate secondary drainage system and continued rains caused flooding in the East Everglades Area from June 7 to about June 20 and in the area east of L-31N and north of C-103. Many requests were made of the SFWMD to remove the plug at S-197. However, the plug was not removed for the following reasons: the effect on the stage in the flooded areas would have been minimal; removing the plug would cause extensive large environmental damage in Barnes Sound; and the operational criteria for plug removal were not reached. Minimal pumping was done at S-331 throughout the storm event as long as all stages south of the station were not exceeded. The question arises why flooding occurred when the design stages were not exceeded. First, the design stages in L-31N are close to the natural ground elevation and secondly, there is an almost complete lack of a secondary drainage system in the area.

2.9.9 Storms of August 1988

During August 1988 Pump Station S-331 recorded cumulative precipitation of over 18 inches. Successive storm events and resulting high stages in the C-111 basin necessitated the removal of the earthen plug at S-197 on August 15. Continued rains precluded replacement of the plug for seven days. The removal of the earthen plug allowed approximately 45,000 acre-feet of fresh water into the Manatee Bay/Barnes Sound marine environment. As a result of the exceptionally high rainfall in the early summer months and the discharge of freshwater from C-111, a massive die-off of benthic fauna and flora occurred. S-331 was operated to facilitate seepage of flood waters from the East Everglades Area whenever possible. This procedure was suspended, however, whenever the primary areas protected by the C&SF Project were endangered. Releases through S-333 were terminated during the third week of August as groundwater levels in the monitoring wells surpassed thresholds. As the stage rose in Water Conservation Area No. 3A into the Zone A Flood Operations, the gates at the S-12 structures were opened fully. After two weeks of fully open-gate operations, the stage finally reversed its upward trend.

2.10 LAND USE

Existing land uses are primarily agricultural in the northern and central portions of the C-111 basin, with moderately urbanized areas near Florida City and Homestead. Ground level contours range from 1 to 10 feet NGVD with most of the active agricultural and urban land use at land elevations of 5 feet and above. The southern-most portion of the basin is characterized by abandoned farmland and natural wetlands sloping gradually to Florida Bay.

An estimated 36,800 acres are utilized for fruit tree groves, row and field crops, and plant nurseries. The limestone rocklands, which account for most of the agricultural acreage, and marl soils are prepared for multiple varieties of subtropical and tropical fruits grown in south Dade County.

The original tabulation of land use acreage within the C-111 basin was conducted in 1986. While agricultural activity in the region was severely impacted by Hurricane Andrew in August 1992, agricultural production is recovering quickly after the event. There is currently approximately 42,700 acres of land within the economic study area of which approximately 36,800 acres or 86% are utilized for agricultural purposes. Tropical fruit groves and nurseries accounted for some 13,600 acres, with vegetable tracts, field crops, and fallow areas accounting for the remaining acreage. Within the area of economic analysis, urban land accounted for a little more than 4% of the land use activity, with wetlands and other open lands accounting for almost 10% of the area. More detailed information on land use within the study area can be found in this report in Appendix E, Economic Analysis.

2.11 RECREATION

Fishermen use the existing canals and waterways for fishing access. Although structures such as pumping stations and culverts prevent linear use of the entire drainage system, there are some stretches where boaters can travel for several miles from their entrance point. Not all portions of the drainage system are accessible, since highways and/or boat launching ramps are not available and culvert structures obstruct water travel. Airboats, capable of traveling across the marshes, can gain entry to some of these isolated stretches of water. Those stretches outside the park which are accessible by boat or by road do sustain an active use by fishermen. However, in the C-111 system, there is very little boating or fishing use except downstream of the coastal structures.

Hunters make some use of the project area during the appropriate hunting seasons throughout the year. A variety of birds and small game is taken by the hunters using sites designated for this activity.

Birdwatching is a year-round activity which occurs in the project area also. This non-consumptive activity is enjoyed by many people because of the variety of birdlife available in the Everglades and south Florida.

2.12 CULTURAL RESOURCES

Human occupation of Everglades National Park area is documented to have occurred only within the last 2,000 years, although evidence of occupation in other parts of South Florida dates back to over 10,000 years ago (Griffin 1988). An archeological survey was conducted by Carr (1983) in Dade County, near the project area as part of an application for rock plowing. One potentially significant archeological site, Da3218, was identified on a tree island during the survey. Three additional tree islands near site Da3218 were not investigated, but were identified as having the potential to also contain significant archeological resources. The few known archeological sites in Taylor Slough are isolated from the major districts of settlement in the Everglades, in the Ten Thousand Islands area and Shark River Slough. Three earthen midden sites, Paradise Key I, Taylor Slough #1, and Taylor Slough #2, and one subsurface site, the Anhinga Trail site, are recorded in Taylor Slough. The National Register eligibility of these sites has not been assessed, but several of the sites probably meet the eligibility criteria. The project area has not been subjected to systematic cultural resources survey, and other unrecorded historic properties may be present. Required surveys will be conducted following project design, and before construction.

2.13 AESTHETICS

The agricultural lands, canals, levees and control structures provide a human contrast with the marshes which are also found in this section of the state. The majority of the areas which will be impacted by this project have been altered by man over a relatively long period of time. Aesthetically, the area has a positive value because of the abundant wildlife and extensive waterways and marshes. Even the agricultural lands have a mixed variety of wildlife on them.

2.14 AIR QUALITY

Air quality is that of a rural, non-industrial area. Principal agricultural activity is winter vegetable production. Pesticides may be applied from the air, but there are no air quality issues.

SECTION 3

FUTURE "WITHOUT PROJECT" CONDITION

This section provides a forecast of future conditions in the C-111 Basin that are likely to occur if no Federal project is implemented. The future "without project" condition is synonymous with the "no action" alternative required pursuant to the National Environmental Policy Act of 1969, as amended. It is also referred to as the Base Condition in other sections of this report.

3.1 C-111 PROJECT

In the future "without project" condition, the existing C-111 project for flood control and other purposes would remain in place and would continue to be operated and maintained. The "without project" condition for this study assumes, however, that the Modified Water Deliveries to Everglades National Park (MWD to ENP) Project, authorized in 1989 by PL 98-181, is in place and operating. The without project canal stages would return to the optimum stages as listed in Table 2-1.

3.2 MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK

The future "without project" condition includes structural and operational modifications to the water management system that are included in the Modified Water Deliveries to ENP Project. This project is in the design and construction phase. It consists of structural modifications to the C&SF Project to provide more natural flows to Shark River Slough in ENP. Water flows will be spread across a broader section of Shark River Slough to include the East Everglades, between L-67 Extension and L-31N. In conjunction with the MWD to ENP project, Department of Interior is acquiring about 107,600 acres in the East Everglades for incorporation into the park. These lands are identified in Figure 1-4.

Structural components of the plan are also shown in Figure 1-4. The project consists of the addition of water control structures to reestablish the natural distribution of water within Water Conservation Area (WCA) No. 3A (S-349A, B, and C) and culverts to restore flows into WCA No. 3B (S-345A, B, and C). Outlets from WCA No. 3B (S-355A & B) will be constructed to discharge into Northeast Shark River Slough. An existing levee and canal (L-67 Extension) along the eastern edge of the Slough. An existing ENP boundary will also be removed. A Miccosukee Indian camp will be floodproofed to avoid periodic flooding that would otherwise be caused by the project.

As a part of the project design process, the L-67 Pilot Test is being conducted. This test is to obtain data that will help identify the most cost effective alternative plan for discharging water from WCA No. 3A to WCA No. 3B, while still accomplishing the project objectives. Depending on the results of the pilot test, the recommended plan may be modified to replace the construction of the S-345's and S-349's with a less costly alternative.

In order to prevent adverse flood impacts to the 8.5-square-mile residential area, the project includes the construction of a seepage levee and canal around the western and northern edges of the area and a pump station (S-357) to remove excess seepage water. These project features are designed to maintain the existing level of flood protection in the residential area after the MWD to ENP project returns water levels in Northeast Shark Slough to natural (slightly higher) levels. A second pump station (S-356) would be constructed to pump excess seepage water from the L-31N borrow canal and residential area into the L-29 borrow canal. This water will then flow through culverts under US Highway 41 into Northeast Shark River Slough.

Legislation has been approved by Congress (Feb 94) and signed by the President that authorizes the Department of Interior to utilize existing appropriations to contribute up to 25% of the cost of acquiring the 8.5-square-mile area, the Rocky Glades Agricultural Area, and the Frog Pond. Acquisition will be performed by the South Florida Water Management District with contributions from the State and Dade County, in addition to the Department of Interior. Once acquired, the lands would be managed by SFWMD. The legislation would not require acquisition of all these lands. It would provide the opportunity to acquire the lands if the participating agencies agreed. If the 8.5-square-mile area were to be acquired, the proposed levee, canal, and pump included in the Modified Water Deliveries to ENP Project would not be constructed. However, the remainder of the project features in the Modified Water Deliveries to ENP Project would be constructed and the project would function as intended.

Operating studies are being conducted during design and construction of the project to identify the optimum operating plan. The structural modifications were designed to provide for maximum operational flexibility so that as more is learned through the continued iterative testing program, the operation of the project can be adjusted accordingly.

3.3 WATER MANAGEMENT

3.3.1 Plan for Water Control - ENP-South Dade County Conveyance System

Authority for conducting the Experimental Program for Modified Water Deliveries to ENP expires upon completion of construction of the Modified Water Deliveries to ENP Project. The future "without project" condition calls for the ENP-South Dade County Conveyance System canals and structures to be operated in accordance with the original design criteria, as described in Table 2-1. The timing, volume, and specific location of water deliveries from the C&SF Project to Shark River Slough will be made in accordance with the operating plan developed during project design and construction. S-331 is the divide structure between the Northeast Shark River Slough and South Dade County drainage areas. It will no longer be utilized to pump flood waters out of the Shark River Slough basin to prevent flood damages in the 8.5-square-mile area. It will be used, as designed, for water supply deliveries to South Dade County during drought conditions.

3.3.2 Flood Control

Without the C-111 project, the basin will continue to experience substantial agricultural flood damage. Agricultural flood control in South Dade County is impacted by the adjacent canal water levels that exist prior to, and during a storm event. As a part of the Experimental Program for Modified Water Deliveries to ENP, optimum canal stages have been lowered for selected canal segments. The existing condition includes the Experimental Program which calls for an optimum canal level in L-31N, between S-331 and S-176, of 5.0 ft. This is 0.5 ft lower than the design optimum. In the future "without project" condition, this canal will be operated at the original design optimum canal stage of 5.5 ft. Because this canal segment is immediately adjacent to large agricultural areas, there will be some reduction in flood protection in the future "without project" condition, relative to the existing condition.

During a flood event, S-331 (and S-173 which is adjacent to S-331) will be utilized as a divide structure. It will separate the Shark River Slough basin north of S-331 from the Taylor Slough basin runoff to the south. Excess flood water south of S-331 will be discharged at S-175, S18C, and under extreme conditions, at S-197. The future "without project" condition will result in flood discharges to Taylor Slough via S-175 that bypass the center of the flowway.

Occasional flood discharges to Barnes Sound will continue to be necessary to the detriment of native flora and fauna. However, the frequency of such discharges should be significantly reduced. SFWMD has modified the plug at S-197 by adding 10 culverts adjacent to the existing three culverts. This will provide the operational flexibility to limit S-197 discharges to non-damaging levels during most storm events.

3.3.3 Water Supply

3.3.3.1 Agricultural and Urban Water Supply

The ENP-South Dade County Conveyance System will function, as designed, to provide supplemental water supply deliveries during drought conditions. Groundwater recharge from the canals should not change significantly in the future "without project" condition. Coastal salinity control structures will continue to be operated in accordance with the design operating criteria. Therefore, upstream canal stages should remain unchanged and saltwater intrusion is not expected to become more of a problem as a result of the project. However, a continued rise in sea level may make it necessary to operate the canals at higher levels to avoid saltwater intrusion in the future. No significant changes in the project's ability to provide for agricultural and urban water supply are anticipated in the future "without project" condition.

3.3.3.2 ENP Water Supply

The future "without project" condition will include restoration of more natural flows to Shark River Slough (Modified Water Deliveries to ENP Project). Since the operation of L-31N and C-111 will be in accordance with the original design criteria, large volumes of water will continue to be drained from Northeast Shark River Slough and northern Taylor Slough into the canals. This will continue the current trend of degradation of ENP's natural resources caused by alterations to the natural hydrology.

The Modified Water Deliveries to ENP Project will result in higher water levels in northeast Shark River Slough which will cause increased seepage into the L-31N borrow canal. Under a flood condition, this seepage will be pumped northward and returned to Shark River Slough from the L-29 borrow canal through culverts under US Highway 41. This is necessary to avoid having to discharge to the south which could exacerbate flooding in the C-111 basin. During normal (non-flood) conditions, excess seepage water could be discharged southward under some circumstances. This would enable greater discharges to Taylor Slough via S-332 in the future "without project" condition.

Operation of the system could be adjusted slightly to take advantage of additional water deliveries from upstream of S-331. However, the existing physical water management system is not designed to provide sufficient distribution and operational flexibility to fully take advantage of the additional water. Although operational criteria for the existing structures and canals can be modified, it is unlikely that significant changes could be made without causing adverse impacts to adjacent agricultural lands. Since overdrainage of the Everglades by seepage into project canals dominates the hydrology in this area (Van Lent and Johnson 1993), under "without project" conditions it is not expected that the additional water would significantly contribute to restoration of more natural hydrology.

3.4 CLIMATE

There will be no further effect on climate in the without project condition.

3.5 LAND USE

The future "without project" condition includes continuation of agricultural usage of the Frog Pond and Rocky Glades agricultural area. Projections of future land use in the study area would indicate some growth of residential areas with little or no growth in agricultural acreage. Tracts utilized for tropical fruit groves, Cuban vegetables, specifically guava and papaya, and ornamental horticulture are expected to replace some of the more traditional vegetable acreage used for tomatoes, beans, corn, and squash. Market price is excellent for these commodities, production practices are improving and new methods have been developed to make these crops more disease resistant.

Open rockland soil areas bordered by C-111, L-31W, and State Road 27 will continue to be utilized for nontropical row crops, particularly tomatoes. Urban development around Homestead and Florida City should show controlled growth of low to low-medium density residential areas with an upper limit of 13 dwelling units per acre. New residential development should include single family homes, townhouses, or small apartments after recovery from Hurricane Andrew.

Hurricane Andrew destroyed most of the fruit trees in the Canal 111 study area in 1992. At present, an exact estimate of the acreage of fruit trees that will be replanted is unknown. Most of the fruit crop acreage affected by Hurricane Andrew has already been replanted west of Levee 31N. East of the levee, discussions with the Dade County Extension Office and the United States Department of Agriculture (USDA) indicate that 50% to 100% of the trees will be replanted. These new trees will continue to mature and reach full production during the project life.

Operating conditions in the C-111 basin have been below optimum levels for several years due to the Experimental Program of Modified Water Deliveries to ENP. A return to optimum stages in the canal system will primarily affect two areas. The Rocky Glades area west of Levee 31N is located in the East Everglades Area. Much of the agricultural acreage is utilized for fruit production and little, if any existing water control exists. A return to authorized stages will worsen conditions to agriculture in this area. The second affected area includes the Frog Pond adjacent and east of Levee 31W and selected areas south. Effects upon crops in this area will depend upon seasonal regulation of canal stages. Tomatoes are grown during the dry winter months generally from November to March but land preparation can begin as early as late August and early September. Returning to authorized stages in the canal system during this period will inhibit production practices in this area.

3.6 RECREATION

Without the project, the hunting, fishing, boating and wildlife viewing wil continue. In all likelihood, an increase in these activities will occur in direct proportion to the growth in population in the south Florida area.

3.7 WATER QUALITY

Agricultural and urban areas in the northern Everglades are expected to continue to influence water quality in the study area and Everglades National Park if no further action is taken. If the Everglades litigation is resolved, flood runoff from the Everglades Agricultural Area will meet all applicable water quality standards before it is discharged into the WCA's. As a result, discharges from WCA No. 3A to the ENP-South Dade County Conveyance System will be of sufficient quality to insure no degradation to Everglades habitat.

It is likely that further research will be conducted to determine the cause of high Mercury levels in Everglades water. It is also likely that restrictions will continue on human consumption of fish removed from the Everglades.

3.8 ENVIRONMENTAL RESOURCES

Prevalent hydrology, different from the historic natural (Section 3.3.3.2), will continue to characterize the Taylor Slough--C-111 basin. Seasonal overflow of water from Shark River Slough (SRS) into the Taylor Slough basin would increase under the Modified Water Deliveries to Everglades National Park Project (USACE, 1992), but large volumes of water will continue to be drained from Northeast Shark River Slough and northern Taylor Slough into the L-31N borrow canal and C-111. Water levels in the Taylor Slough basin would continue to be largely unrelated to rainfall, drier-than-natural conditions would continue, and undesirable vegetative trends would continue.

Present vegetative trends in the study area include an invasion of native and exotic woody plants into the historic sawgrass-spikerush prairies. The invader plants, willow, primrose, myrtle, find suitable footholds where the wet prairie has become dry at the surface for extended periods annually. This conversion of habitat type is symptomatic of a fundamental change in the ecosystem from an Everglades wet prairie system toward a mesic prairie system. This trend would continue under the "without project" flow regime.

In Manatee Bay, Barnes Sound, and Florida Bay, cycles of unnatural salinity conditions will likely continue. Discharges of large flow volumes to coastal receiving waters will occur within short time periods following major storms. This will result in significant swings in salinity, from 0 to levels well in excess of seawater salinity. The impact on the area biota will continue to be significantly negative.

3.9 MANAGEMENT

The Everglades will survive only as a managed systém. In order to restore and maintain a naturally functioning biosystem coexisting with an intensively used human system, the water resource must be protected and directed. The water supply comes from rainfall, but it will continue to be managed by man as it is allocated among potential users.

SECTION 4

PROBLEMS AND OPPORTUNITIES

This section will address problems and opportunities associated with flood damage reduction, environmental resources, and alteration of the natural hydrology.

4.1 FLOOD DAMAGE REDUCTION

One of the primary purposes of the South Dade County portion of the C&SF Project is flood protection. The project was authorized to remove 40-percent Standard Project Flood flows. This purpose remains an important objective because of the agricultural intensity within the study area. Land use in the original project was predicted to show an increase in agriculture and urban development in the Homestead and Florida City area, and industrial development further south. The industrial development did not take place, but considerable agricultural and some urban development has occurred. Intensified agricultural land use activities within the basin necessitates an improved water management capability. Extended durations of flooding have adversely impacted basin agricultural productivity.

In the design of the original flood control project for the C-111 basin, it was assumed that the basin would be developed for seasonal row crops. As a result, flood control would be required only for the winter growing season which coincides with south Florida's dry season. Row crops only require protection of root zones which generally extend slightly below the ground surface. However, tree crops have been planted in the basin. The amount of fruit tree crops and general horticultural activity have increased substantially since the 1960's. Many of these, such as avocado and lime trees, are very susceptible to inundation of their root zones, and require year-round flood control for root zone depths of 2 to 4 feet. As these activities have longer root zones they are more susceptible to damage from high water tables in the area, even when planted on higher ground or on mounds.

Ground elevations in the C-111 basin are extremely flat, ranging in elevation from just above sea level to above 7 feet, NGVD. Agricultural lands in the basin are generally located on land above 5 feet, NGVD, although there is some agriculture, particularly in the Frog Pond at lower elevations. The C&SF Project features provide flood control by draining groundwater from agricultural lands to minimize or avoid root zone inundation. This is done by operating canal stages below the adjacent groundwater elevations to create a flow gradient toward the canal. These flows are collected in the canals and are discharged, for the most part to Taylor Slough (at S-332), to the park's panhandle via S-18C and lower C-111, and to Manatee Bay/Barnes Sound under extreme conditions.

The same physical processes that drain water from agricultural lands during flood conditions also drain water from Taylor Slough, west of L-31N and L-31W. There has been a conflict between agricultural needs (predictable canal levels that are not allowed to rise during the growing season) and the needs for restoration of Taylor Slough (levels that fluctuate naturally in response to rainfall patterns).

Flood damage susceptibility is measured without and with proposed alternatives. The differences represent the inundation reduction benefits of the proposed project. A detailed explanation of procedures used in the determination of these damage estimates is presented in Appendix E, Social and Economic Analysis.

The basin experiences substantial agricultural flood damage. The evaluation in Appendix E demonstrates that under existing land use conditions, flood damages are estimated to range from \$2.3 million (4,500 acres) during a 2-year storm frequency, \$8.0 million (7,600 acres) during the 10-year storm frequency to \$93.6 million (31,700 acres) during the standard project flood (SPF) event.

4.2 ENVIRONMENTAL RESOURCES

4.2.1 Everglades National Park

ENP personnel have found that *the ecological integrity of the entire Everglades ecosystem has declined over the past several decades. This is evidenced by a 90 percent decline in the number of nesting wading birds, changes in the historical distribution and abundance of higher trophic-level consumer populations, reduced hydroperiods, loss of marsh productivity, increased frequency of alligator nest flooding, and an overall loss of wetland habitats. The general health and continued survival of native wildlife populations within Everglades National Park is at risk unless restoration of naturally functioning ecological processes can be attained* (National Park Service, 1990). ENP relates these problems to the reduced area and changed timing of surface inundation resulting from the C&SF Project.

4.2.2 Manatee Bay/Barnes Sound

On five occasions since construction of S-197 in the mid 1960's, it has been necessary to remove the earthen plug adjacent to the S-197 culverts in order to provide full canal conveyance for flood control. The most recent removal of the plug was in 1988. Forty-five thousand (45,000) acre-feet of water were discharged to Manatee Bay/Barnes Sound (SFWMD 1988). Salinities in this lagoon area generally range from 30 - 40 ppt, but were much lower (about 20 ppt) than normal due to exceptionally high rainfall in the early summer months prior to the plug removal in August. These lowered salinities caused the Manatee Bay/Barnes Sound system to be in a "stressed" condition. Following the removal the plug, salinity in Manatee Bay was reduced from 20 ppt to a low of only about 1 ppt. The salinity in the larger, more distant Barnes Sound declined to a low of about 15 ppt. In 1988, the discharges from

C-111 were sufficient to lower salinities below 15 ppt in a 25-square-mile area. A massive die-off of flora and fauna occurred in Manatee Bay/Barnes Sound (ibid).

A major problem at S-197 was the inflexibility of discharge capability. With the plug in place, only minimal discharges were possible through the 3 culverts at S-197. When a major flood occurred, there was no option but to remove the plug for maximum discharges. The earthen plug adjacent to the 3 culverts at S-197 has been replaced with 10 additional culverts. This will allow earlier discharges at lower rates that will preclude the need for making maximum discharges in many circumstances. Most importantly, the culverts will enable minimizing the total volume of discharges to Manatee Bay/Barnes Sound during all events. However, during major storms, it will still be necessary to make large discharges through the culverts.

4.3 ALTERATIONS OF THE NATURAL HYDROLOGY

Restoration of Taylor Slough and Florida Bay is dependent, in large part, upon restoration of the natural hydrologic conditions under which the ecosystem evolved. Construction and operation of the C&SF Project have resulted in substantial changes to the natural hydrology of Taylor Slough. Satisfying the Congressionally authorized project purposes of flood control and water supply required alterations to the natural hydrology. Satisfying the Congressionally authorized project purpose of protecting the area's fish and wildlife resources depends upon allowing the natural hydrologic variations to occur between flood and drought.

4.3.1 Taylor Slough Hydrology

Taylor Slough can be divided into four physiographic sub-zones; the headwaters, upper, middle, and lower zones. The headwaters can be defined as the area bordered on the north by the 8.5-square-mile area and extending southward to the Frog Pond. The upper zone extends from S-332 southward past the park road to the area of Anhinga Trail. The middle zone extends from Anhinga Trail southward approximately four miles to the general location of the Madeira ditches. The lower zone refers to the segment from the Madeira ditches to the mangrove fringe along Florida Bay.

Soil descriptions prepared by the University of Florida and USDA (Leighty et al. 1954) indicate that under natural conditions essentially all of the study area, except the higher elevated Atlantic Coastal Ridge, was subjected to seasonal flooding due to low ground surface elevations and the close proximity to the Everglades. At Tamiami Trail, the concave depression that shaped the "River of Grass" is constricted, forming a narrow southwesterly trending arc of continuous wetlands which define the Shark River Slough drainage. Shark River Slough represents the southern extension of the Everglades trough, which originates outside of the Park in the wetlands of WCA No. 3. To the northwest of Shark River Slough, the bedrock of the Everglades rises gradually into the sandy marl prairies of the Big Cypress basin. This area extends well south of Tamiami Trail, forming the transitional and short hydroperiod marshes to the west of the L-67 Extension borrow canal. These marl prairies occur on slightly higher bedrock elevations, and were originally only seasonally inundated.

To the southeast of Shark Slough is a large area of transitional (less than 3 months hydroperiod) and short hydroperiod (3 to 5 months hydroperiod) wetlands referred to as the Rocky Glades. The Rocky Glades includes the headwaters and a portion of upper Taylor Slough and extends east of L-31N for several miles.

Maximum inundations in the Rocky Glades occurring after the peak of the rainy season, formed a natural buffer separating the deeper Everglades marshes from the higher elevated, and drier areas along the Coastal Ridge. During the wet season, the Rocky Glades would receive runoff from the western portion of the Coastal Ridge, while additional surface water would spill over from the expanding Shark Slough wetlands. The shallow soils and exposed limestone bedrock in the Rocky Glades make it an important area of direct recharge to the underlying aquifer, which supplies groundwater flows to the adjacent eastern developed areas as well as the downstream Everglades.

The Rocky Glades are hydrologically significant, since the southern portion of this area drains to the southeast, where it forms the headwaters of the Taylor Slough watershed. The marl soils in upper Taylor Slough extend eastward, covering much of the Frog Pond, and northward along the western flank of the Coastal Ridge. Under natural conditions, this region captured wet season runoff from the western Coastal Ridge and directed it westward into Taylor Slough, where it would be slowly released into the downstream marshes and Florida Bay. Construction of the L-31N, C-111, and L-31W levees has isolated much of the historical contributing area to Taylor Slough, and excess wet season runoff from this region is now rapidly drained via the canal systems eastward to Biscayne Bay or southward into the lower C-111 basin. These C&SF Project features contribute to the drainage problems in the eastern wetlands within ENP.

4.3.2 Past Hydrologic Changes in Southwestern Dade County

The earliest C&SF Project construction in southwestern Dade County began in 1951, with the completion of L-30 and the northern portion of the L-31N levee. These levees were originally built as part of the Eastern Protective Levee System, to protect the expanding developed areas of the Lower East Coast from Everglades flooding. This levee system also established the land use plan for western Dade County and areas to the north, by defining the western limit of flood protection.

The original plan of improvement for southwestern Dade County also anticipated that the majority of the low-lying areas east of the L-31N and C-111 levees and adjacent to the Everglades would be developed for seasonal agriculture (U.S. Army Corps of Engineers 1961). This plan called for gravity drainage of an area of 227 square miles of southwestern Dade County using a system of 12 primary canals. Although it was recognized that the natural drainage in the western portion of the Coastal Ridge was to the southwest (into Taylor Slough), gravity drainage primarily to the east and south (into Biscayne Bay, Barnes Sound, and Florida Bay) was found to be most practical, particularly with the continuing pattern of declining groundwater levels in the Coastal Ridge.

Runoff from the east of L-31N and north of Homestead was to be drained eastward into Biscayne Bay via six proposed canals (C-101 through C-106). The area south of Homestead was to be drained southward into Florida Bay and Barnes Sound via six proposed canals (C-107 through C-112). During project review, the National Park Service concurred with the plan for eastern Dade County, but requested that the area west and northwest of Homestead be drained westerly into Taylor Slough, to reduce the drainage effects of the C&SF Project improvements. The National Park Service and the Fish and Wildlife Service also objected to the southerly extension of the proposed C-109, C-110, C-111, and C-112 canals to tidewater, and requested that the canals be terminated at the one-foot contour to promote sheetflow, and reduce the effects of direct freshwater inflows to the downstream estuaries.

The 1961 plan was modified in the South Dade County GDM (US Army Corps of Engineers 1963) so that the L-31N canal would be used "to provide southerly drainage to ENP in Taylor Slough for the westerly portion of south Dade County". The L-31W canal was specifically added as part of the 1963 GDM so that during the design storm approximately 28 square miles of land adjacent to the C-102 and C-103 canals would be drained westward into Taylor Slough. The first proposed operating criteria for the southern reach of the L-31N borrow canal would have allowed wet season canal stages to rise as high as 6.5 feet, NGVD to promote the discharge of water into Taylor Slough via the L-31W borrow canal. Later, when more detailed topographic data were available, the design optimum canal stage was changed to 5.5 feet, NGVD. However, the intent was to maintain canal stages as high as possible to enhance water supply for ENP. Water would spill overbank from the L-31W borrow canal into Taylor Slough. Under flood conditions, up to 500 cfs would be discharged into the L-31W canal and pass southward via S-175, to maximize Taylor Slough inflows.

Prior to construction of the C&SF Project, the farming practices in this region had been adapted to the natural cycle of Everglades flooding and drying. Land preparation and planting would begin after wet season water levels naturally receded. Agricultural practices were thus in tune with the natural variability in seasonal rainfall and water levels. During the 1980's, agricultural practices in the region began to change, in part due to a lower than normal decade of rainfall. Grove crops, which require low ground water levels throughout the year, expanded into the western portions of the basin. In addition, economic pressures forced south Dade farmers to plant their row crops earlier in the season to compete with growers from other areas. Both of these changes prompted additional demands to lower canal operational stages. This would increase groundwater storage potential so there would be a readily available area to absorb the stormwater runoff. As a result, the risk of flooding of the root zones would be reduced.

The operational levels maintained in the L-31N, L-31W, and C-111 borrow canals are also extremely important to the natural areas in the eastern section of the Park. These canals traverse the Rocky Glades and canal water levels largely control the magnitude of groundwater losses from the Northeast Shark Slough and Taylor Slough basins. The underlying limestone of the Rocky Glades is the most permeable bedrock found in South Florida. Minor reductions in canal water levels drain tremendous quantities of surface and ground water from the wetlands. Maintenance of higher surface and ground water levels in this area is pivotal to the restoration of flows throughout Northeast Shark Slough, Taylor Slough, and into the downstream estuaries of the Gulf of Mexico and Florida Bay.

The immediate loss of stormwater runoff to tide during the rainy season and the continued drainage of the wetlands and stored groundwater into the dry season not only cause the loss of natural hydroperiods in the uplands, but also cause a drastic reduction of freshwater flow into the downstream estuaries during the remainder of the dry season. The resulting reduction in groundwater levels further aggravate the problem when the early spring rains arrive. Rainfall must first fill up the depleted groundwater regime before surface water flow can resume, and transport freshwater into the downstream marshes and estuaries.

4.3.2.2 The Impacts of Water Management in the Rocky Glades

The impacts of water management changes in the Rocky Glades most likely date back to the beginning of drainage activities in the Everglades watershed in the early 1900's. Unfortunately, little hydrologic information exists for the pre-drainage Everglades. Water level recording gages G596 and G789 are long-term monitoring stations in the Rocky Glades. They were installed in the late 1940's and mid 1950's (see Figure 1-4 for locations) after significant drainage activities had already taken place. Even with this late start, the gage data indicate that the transitional wetlands in these areas were routinely subjected to short periods of seasonal flooding until approximately 1962, when L-29 was completed, enclosing WCA No. 3.

Table 4-1 provides a brief summary of the water level and hydroperiod changes that have occurred in the Rocky Glades area. Prior to 1962, average wet season water levels exceeded 6.9 feet at the G596 gage, and exceeded 5.80 feet at the G789 gage. After 1962, average October water levels dropped by 1.2 to 1.5 feet at these gages. Similar reductions have occurred in average water levels during the late dry season.

The reduced water levels have had a profound affect on hydroperiods in the Rocky Glades. Prior to 1962, surface water inundations occurred on average, 13 to 14 percent of the time. After 1962, surface water inundations occurred less than 1 percent of the time. More importantly, groundwater levels have become so low that much of the Rocky Glades has water levels several feet below the ground surface throughout the year. Under these conditions, rainfall rarely raises water levels to the point where surface water flows are produced, so the Rocky Glades have lost much of their ability to contribute flows to the Taylor Slough watershed, except under extreme rainfall events.

Table 4-1

Water Level and Hydroperiod Changes in the Rocky Glades
(Key Stages are 6.0 feet at G596 and 5.0 feet at G789)

	PRE-1962		POST-1962	
SITE NAME	AVERAGE OCTOBER WATER LEVEL	AVERAGE APRIL WATER LEVEL	AVERAGE OCTOBER WATER LEVEL	AVERAGE APRIL WATER LEVEL
G596	6.93	4.96	5.71	3.47
G789	5.82	3.22	4.35	2.03
SITE NAME	PERCENT TIME GREATER THAN KEY STAGE	PERCENT TIME GREATER THAN GROUND SURFACE	PERCENT TIME GREATER THAN KEY STAGE	PERCENT TIME GREATER THAN GROUND SURFACE
G596	57	13	11	<1
G789	41	14	7	<1

Wet season water levels show a further reduction in the early 1970's. The reduced water levels in the 1970's are thought to be a primary factor responsible for the increased agricultural and residential development throughout the low-lying areas of western Dade County. This has even allowed development to expand into the unprotected areas west of the Eastern Protective Levee System. This area remained relatively dry throughout the 1970's, as a result of a long period of lower than normal rainfall, the continued diversion of sheetflow away from NESRS, and slightly improved drainage from the adjacent canals to the east. In spite of this, the agricultural and urban areas west of the L-31N are extremely susceptible to flooding, since the C&SF Project has no project features or provisions to provide flood protection in these areas.

4.3.2.3 The Impacts of Water Management in Taylor Slough

Water level monitoring stations in the Taylor Slough basin were also installed well after the start of drainage activities in the Everglades. The earliest monitoring data for the upper Taylor Slough area began at the bridge over Taylor Slough in late 1960. Monitoring began in the lower Taylor Slough area in early 1953. Table 4-2 provides a brief summary of the water level and hydroperiod changes at these two monitoring sites. The comparison in table 4-2 breaks the record based on the start of construction of L-31N and C-111 in early 1965. Note that average wet season water levels at Taylor Slough Bridge and at P-37 show very little change. During the late dry season, water levels at the Taylor Slough Bridge have increased, as a result of supplemental water deliveries from the ENP-South Dade County Conveyance Canal system. Station P-37 shows no apparent water level or hydroperiod changes because it is located in the lower portion of the watershed, and the effects of local rainfall and its close proximity to tide, overshadow the impacts of upstream water management.

Table 4-2

Water Level and Hydroperiod Changes in the Taylor Slough Basin
(Key Stages are 3.0 feet at TSB and 0.8 feet at P-37)

	PRE-1965		POST-1965	
SITE NAME	AVERAGE OCTOBER WATER LEVEL	AVERAGE APRIL WATER LEVEL	AVERAGE OCTOBER WATER LEVEL	AVERAGE APRIL WATER LEVEL
TSB	3.83	0.54	3.71	1.24
P-37	1.67	0.24	1.62	0.25
SITE NAME	PERCENT TIME GREATER THAN KEY STAGE	PERCENT TIME GREATER THAN GROUND SURFACE	PERCENT TIME GREATER THAN KEY STAGE	PERCENT TIME GREATER THAN GROUND SURFACE
TSB	41	24	41	28
P-37	76	76	74	74

4.3.2.4 Restoration Goals for the Rocky Glades, Taylor Slough, and Florida Bay

The wetlands throughout the Rocky Glades and Taylor Slough have experienced major changes in their original patterns of seasonal flooding and sequential drying as a result of reduced surface water inflows, the redirection of stormwater runoff to the eastern coastal canals, and the drainage effects of the canal system along the Park's eastern boundary. These hydrologic alterations have subsequently led to a reduction in the spatial scale of these wetlands, a loss of habitat heterogeneity, and declines in ecosystem productivity, that can be seen in many of the key plant and animal communities within the Park and adjacent natural areas. The current plan for Modified Water Deliveries to Everglades National Park is designed to address many of these concerns through the re-introduction of sheetflow, and restoration of more natural water depths and hydroperiods in Northeast Shark Slough. This effort to re-establish higher surface water levels and longer hydroperiods in the deeper slough is crucial to increasing ecosystem productivity and maintaining adequate freshwater flows to the west coast estuaries and Florida Bay, but these changes alone will not totally restore natural ecological function of the entire southern Everglades system.

Restoring more natural hydrologic conditions in the transitional wetlands of the Rocky Glades is also an essential component of this ecosystem restoration program. Without simultaneously raising groundwater levels and reinstating the historical seasonal inundations in the higher elevated prairies of the Rocky Glades, a key component of the natural diversity of habitats that are needed to sustain the wide range of animal species adapted to the natural Everglades Ecosystem will be lost.

Reestablishing pre-project water levels and the gradual marsh wetting and drying patterns (particularly in the Taylor Slough headwaters) is the most reliable way of restoring the natural timing and distribution of sheetflows throughout Taylor Slough and downstream into Florida Bay. The highest priority for hydrologic restoration must be focused on reestablishing the hydrologic conditions in those areas of the Park that show the greatest impacts due to drainage and altered water management. The transitional wetlands of the Rocky Glades have experienced the most significant water level reductions, and essentially a complete loss of their natural surface water inundations, due to the diversion of surface water inflows from the Northeast Shark Slough basin, and the drainage effects of the adjacent canal system.

The lower canal stages contribute to a loss of sheetflow and natural dry season ponding in Northeast Shark River Slough, increase groundwater losses and shortened hydroperiods in the headwaters of the Taylor Slough basin, and reduce freshwater inflows into the downstream estuaries of Shark Slough and Florida Bay. Reductions in water levels in the adjacent L-31N, L-31W, and C-111 borrow canals, have also altered the operation of the ENP-South Dade County Conveyance System, and limited the capability to provide supplemental flows to restore the hydrology of the Taylor Slough watershed. Water levels, not flow volumes, are the most tangible measure of hydrologic restoration of the wetlands in the Park. Restoring more natural water levels will result in a reestablishment of both the timing and distribution of surface water flows throughout Taylor Slough and into the Florida Bay.

4.3.3 East/West Spreader Canal Lands

The lower C-111 or ENP Eastern Panhandle basin is part of the Southeast Coastal Glades, which are underlain by a mixture of freshwater marls in the areas adjacent to the Coastal Ridge. This area is referred to elsewhere in this report as the east/west spreader canal lands. Near the coast, freshwater marls transition into marine marls (Leighty et al. 1954). Under natural conditions, the lower C-111 basin received the bulk of its runoff from the southern portion of the Atlantic Coastal Ridge. These surface and groundwater flows constitute the primary source of freshwater inflows to the northeastern portion of Florida Bay.

Today much of the southern Coastal Ridge has been developed, and a significant portion of this natural runoff has been diverted eastward into Biscayne Bay. In the mid 1960's, when the C-111 canal was constructed, it formed a breach between the Coastal Ridge and the marl prairies. This has allowed wet season runoff from northern Taylor Slough (and at times runoff from Northeast Shark River Slough) to be transferred into the lower C-111 basin. At the same time, the natural marsh sheetflow was altered by the lower C-111 levees impounding water to the north of the canal which led to overdrainage of the marshes south of the canal.

The southward diversion of runoff from the areas north of the Frog Pond increased freshwater inflows into the lower C-111 marshes and downstream Florida Bay during the 1980's, but the source of most of this water is drainage of the upstream wetlands (Northeast Shark River Slough and the Rocky Glades) within the Park. Thus, the water draining from these areas is transferred through the canal system and re-introduced into the wetlands at a lower point. Recent acquisition by the State of a large tract of the marsh lands north of the lower C-111 basin has led to increased pressure to reintroduce surface water inflows as far north as possible. This has the benefits of maximizing natural marsh sheetflow, and mitigating damaging freshwater releases into the downstream estuaries during periods of high wet season runoff.

SECTION 5
FORMULATION OF ALTERNATIVE PLANS
GENERAL REEVALUATION REPORT

5.1 FEDERAL OBJECTIVE

The Federal objective of water and related land resources planning is to contribute to national economic development (NED) consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.

"*Principles and Guidelines*" published on 10 March 1983 (referred to as "P&G"), specify the rules to be followed by Federal agencies in planning water resources projects. P&G requires that *"the alternative plan with the greatest economic benefit consistent with protecting the Nation's environment (called the national economic development plan, or NED plan) is to be selected unless the Secretary of a department or head of an independent agency grants an exception when there is some overriding reason for selecting another plan, based upon other Federal, State, local and international concerns"*.

Water and related land resource plans are to be formulated to alleviate problems and take advantage of opportunities that occur at the national, state and local levels in ways that contribute to the NED objective. The additional considerations of environmental quality (EQ), regional economic development (RED), and other social effects (OSE) are also evaluated. The environmental quality (EQ) account displays nonmonetary effects on significant natural and cultural resources. The regional economic development (RED) account registers changes in the distribution of regional economic activity that results from each alternative plan. The OSE account registers plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts.

Because of the environmental nature of this reevaluation report, the determination of an NED plan which is normally required for a flood damage prevention project, will not be accomplished within this report. An environmental restoration plan is presented which maintains the flood damage prevention for the study area.

5.2 PLANNING GOALS AND OBJECTIVES

The goal of this study is to formulate a plan of improvement that would restore more natural hydroperiods to Taylor Slough in Everglades National Park and the lower section of C-111, and address flooding problems in the adjacent urban and agricultural areas of the basin in an acceptable and implementable manner.

The following planning objectives were established to address the problems and realize the opportunities identified in the C-111 basin and to serve as guidelines for the formulation and evaluation of alternative plans.

a. Restoration of historic hydrologic conditions in the C-111 basin,

b. Protection of natural values associated with the Everglades National Park,

c. Elimination of damaging freshwater inflows to Manatee Bay/Barnes Sound, and

d. Maintain flood protection for the C-111 basin, east of L-31N and C-111.

It is the policy of the Corps of Engineers to consider in the planning process all practicable and relevant alternatives applicable to sound water resources management. No one alternative is to be pre-judged superior to any other. The fundamental goal is to develop, define, and recommend a solution that has public and institutional support, that is engineeringly feasible and cost effective, and environmentally acceptable.

In this report, the recommended plan is the plan which provides the greatest flexibility to restore the ecological resources within the study area, and minimizes the economic impact to adjacent agricultural land use activities by maintaining flood damage protection.

5.2.1 Restoration of Historic Hydrologic Conditions

Restoration of natural hydrologic conditions in Taylor Slough requires satisfying four requirements: proper volumes, locations, timing, and suitable quality of water flows. This project addresses the reestablishment of more natural volumes, locations, and timing of water flows.

The headwaters and upper portions of Taylor Slough are of particular concern since they make up a large proportion of the original short hydroperiod wetlands remaining within ENP. Short hydroperiod wetlands in the Everglades represent the habitat type that has been most seriously degraded by construction of the water management features (see Tables 4-1 and 4-2). Reestablishing pre-project water levels and the gradual marsh wetting/drying patterns, particularly in the Taylor Slough headwaters and upper zones, is the most reliable way of restoring the natural timing and distribution of sheet flows throughout Taylor Slough.

Figure 5-1 is a schematic diagram of the surface water and groundwater conditions along a transect from the Rocky Glades to Florida Bay (Van Lent and Johnson 1993). It graphically illustrates why it is important to restore natural water levels along the ENP boundary, particularly in the headwaters zone. Restoration of water levels in this area will also lead towards restoration of significantly increased overland sheet flows to the lower portions of Taylor Slough.

An important step in recreating natural marsh habitat is managing water levels to behave in harmony with south Florida's seasonal and annual rainfall variations. Water level fluctuations along the ENP boundary and discharges into ENP must directly correspond to rainfall patterns in the basin.

Restoration of the historic water delivery volumes is important to creating healthy marsh conditions. Optimal utilization of the rainfall runoff in the C-111 basin (south of S-331) is critical for hydrologic restoration. Operational studies to be conducted subsequent to this report will address further enhancing project benefits through inter-basin transfers of supplemental water.

5.2.2 Protection of Natural Values

The primary goal of creating more natural hydrologic conditions in Taylor Slough and the C-111 basin is to restore the historic diversity and abundance of native Everglades flora and fauna.

5.2.3 Eliminate Damaging Freshwater Discharges to Manatee Bay/ Barnes Sound

As discussed in Section 4.2.2, the earthen plug adjacent to the S-197 culverts was removed on five occasions. The most recent removal was in 1988 which caused the salinity in Manatee Bay to drop from 20 ppt to a low on only about 1 ppt. The salinity in Barnes Sound declined to about 15 ppt. A massive die-off of flora and fauna occurred in Manatee Bay and Barnes Sound. Also discussed in Section 4.4.2, the earthen plug has been replaced with 10 culverts by the SFMWD in 1990. In 1992, all 13 culverts were opened and no major damage was recorded.

The goal of this objective is to reduce the number of occurrences of major releases at S-197. Additionally, daily flows could be diverted, if available and desired, to the marsh east of C-111.

5.2.4 Maintain Flood Protection

An objective of this project is to preserve the existing level of flood protection for agriculture in the C-111 basin east of L-31N and C-111. Original project canal

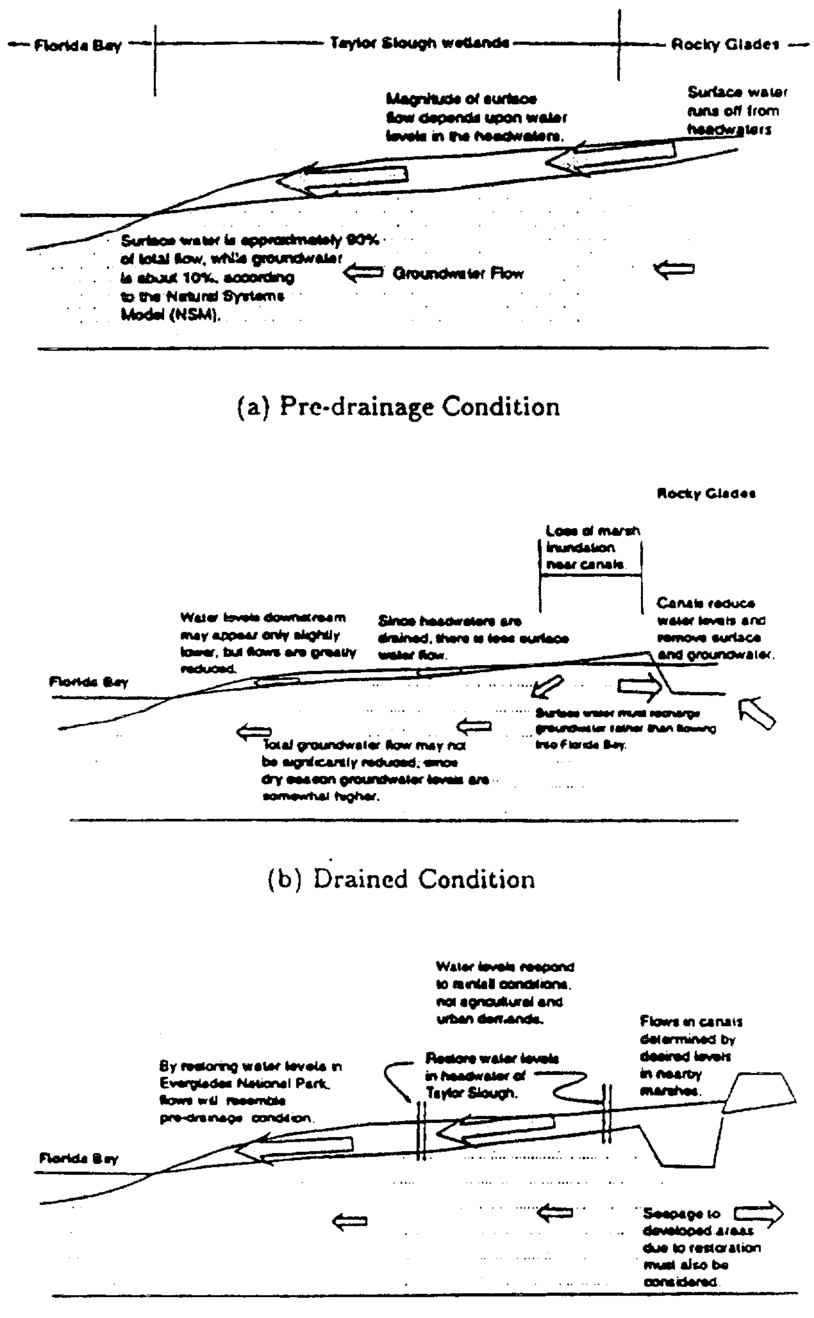


FIGURE 5-1 Restoring water levels in overdrained areas is the key to reestablishing historical flow patterns.

operating levels and structure discharge capacities were intended to provide flood protection for storms up to 40 percent of the Standard Project Flood. This objective involves maintaining the original design canal stages and discharge capacities while restoring more natural hydrologic conditions within ENP.

5.3 PLANNING CONSTRAINTS

While the planning objectives describe the goals of the study, there are certain limitations which must be considered in evaluating any plan for possible implementation. A primary planning constraint within this study is the development of an implementable water management plan which provides both flood damage protection and environmental restoration within the study area.

Since 1988, there has been growing evidence of environmental problems in Taylor Slough and Florida Bay. These problems have been attributed, at least in part, to the operation of the water management system. Because of these concerns, a plan of action has been developed that will enable a timely solution to these problems; thereby minimizing additional degradation. This plan of action calls for separating consideration of structural and operational modifications. This GRR addresses structural modifications to the water management system that will enable greater operational flexibility. Evaluation of the structural plans contained in this report are based on continued use of the existing operating guidelines. Subsequent studies will develop an operating plan that will optimize environmental benefits of the recommended plan.

5.4 PROJECT OPERATIONS FOR ALTERNATIVE PLANS

All alternatives addressed in this report are evaluated using the design operating criteria for flood control and water supply. In order to satisfy the project objective of preserving agricultural flood protection in the C-111 basin, all existing canals and structures are evaluated based on maintaining design optimum canal stages under flood conditions. Furthermore, during drought, supplemental water deliveries are made in accordance with the design operations. The specific design operating criteria are described in detail in Section 2.2.

No additional inter-basin transfers of supplemental water from upstream are made as a part of the operation of any alternatives. Water deliveries to ENP are made when flood control discharges are necessary or in accordance with minimum delivery requirements of PL 91-282. Supplemental water deliveries are made into the C-111 basin only during drought conditions when canal levels drop 1.5 feet below the optimum levels. These deliveries are made to maintain canal stages and are not discharged into Taylor Slough.

Studies will be conducted for the recommended plan during the design and construction phase to identify the optimum operating strategy for C-111 and the Modified Water Deliveries to ENP Projects. The components of the alternative plans are designed so that the design discharge capacities of the various canal segments are maintained for flood control. The critical issues for restoring water flows to Taylor Slough require maintenance of normal day to day discharges and water levels in the proper locations, with the proper timing. The discharge capacity of a system designed for flood control will also have adequate capacity to pass the historic volumes of water. However, the structural system must also be designed to accomplish the remaining hydrologic objectives related to timing and location of water deliveries to Taylor Slough.

5.5 EVALUATION FACTORS

In order to accomplish the goals and objectives of this study, the following evaluation factors will be utilized. These factors are not considered all inclusive.

a. Operational flexibility of the proposed plan of action

b. Cost effectiveness of the plan

c. Environmental benefits

d. Economic evaluation of flood control impacts

5.5.1 Operational Flexibility

The following evaluation criteria are utilized to demonstration each alternative's effectiveness at providing operational flexibility:

a. Maintain natural (higher) water levels along the ENP boundary at the headwaters and upper portion of Taylor Slough

b. Provide ability to control the discharge of water uniformly into the headwaters, upper, and middle portions of Taylor Slough

c. Provide the ability to control the timing of water discharges into the headwaters, upper, and middle portions of Taylor Slough

d. Provide the capacity to restore more natural water flows through the east/west spreader canal

e. Minimize the need for flood control discharges to Manatee Bay/Barnes Sound

f. Enable uniform sheetflow into the lower portion of Taylor Slough

g. Increase hydroperiods in the headwaters and upper portions of Taylor Slough

h. Increase average water depths in the headwaters and upper portions of Taylor Slough.

i. Maintain flood control for the area east of L-31N and C-111.

5.5.2 Cost Effectiveness

Cost effectiveness is evaluated by comparing the total project costs of alternatives that meet the project objectives.

5.5.3 Environmental Benefits

The following evaluation criteria are utilized to demonstrate each alternative's effectiveness at providing environmental benefits:

a. Recreate hydrohabitat units that are closer to historic levels. Hydrohabitat units are a measure of hydrologically modeled outputs of alternatives relative to historic conditions deduced from marl measurements. They depict how well an alternative's hydrology supports the natural values associated with the sawgrass-on-marl ecosystem.

b. Recreate species compatibility indices that are closer to historic levels. These indices are founded on hydrologic habitat criteria defined by ENP staff as favorable to selected indicator species.

5.5.4 Flood Control Economic Impacts

Flood damages reduction benefits are compared with the no-action plan.

5.6 ALTERNATIVES

5.6.1 Background

From 1983-1988 a Supplemental GDM was prepared. The purpose of the study was to complete the authorized plan of improvement for flood control, environmental enhancement and water management in the C-111 basin as constructed in the 1960's. The recommended plan focused on preventing large, damaging discharges to Manatee Bay/Barnes Sound via S-197 and to increase flows to northeast Florida Bay via flows from lower C-111. Details of the plan formulation from this 1988 report are included in Appendix F.

Following completion of the 1988 Supplemental GDM discussed above, the Jacksonville District worked with the staff of the SFWMD and the ENP, to develop plans which would solve problems inherent with the uncompleted project, and the need to improve the area's water management system to meet the study objectives.

In 1990, preliminary plans were coordinated with the SFWMD and the ENP as discussed below. From 1990 to 1992, the Corps utilized an older version of the South Florida Water Management 1x1 Model to evaluate these preliminary alternatives. In order to prepare a Fish and Wildlife Coordination Act Report more detailed hydrologic analysis of the ecosystem was required. With this hydrologic data, the staff of the Everglades National Park was to assess the impacts of proposed alternatives on key ecological, hydrological and biological components, including endangered species, in the C-111 and Taylor Slough basins, northeastern Florida Bay, Manatee Bay, and Barnes Sound. These assessments were to compare the impacts of the alternatives to ecological restoration of the study area. The data produced by ENP was to be utilized by the U.S. Fish and Wildlife Service to prepare a Fish and Wildlife Coordination Act Report.

As originally planned, ENP studies to be utilized in the GRR would have included data collection, development of several species models, and use of the models to evaluate alternatives. This evaluation would have included both structural and operational plan components. However, these studies would have extended the study duration by more than 1 year. Therefore, early in 1993, a decision was made in consultation with SFWMD and ENP to formulate a recommended structural plan. It was also agreed to develop a plan for the operation of the project during design and construction. ENP studies that are underway will be utilized in the operational studies. This strategy enables the most timely resolution of the ecosystem degradation problems in Taylor Slough and Florida Bay.

5.6.2 Preliminary Alternatives

From 1990 to 1992 meetings were held between the agencies participating in the study, to narrow the list of alternative plans and to focus on a solution to the water resources problems within the C-111 basin. These preliminary plans were modeled using the older version of the South Florida Water Management Model 1x1 at the design optimum base condition prior to the interim tests and also with what is considered to be the current condition (prior to the June 1993 test). A description of the plans is provided in the following section of this report.

5.6.2.1 Alternative A

Alternative A as shown in Figure 5-2 includes the diversion of excess floodwater to Taylor Slough and to the C-111E basin. S-174 and the L-31W borrow canal would be enlarged to enable the diversion of an additional 500 cfs to Taylor Slough. S-332 would be enlarged to pass the first 500 cfs of flow and the remainder would be discharged southward via the existing S-175. A new east/west canal would be constructed from C-111E (just north of its intersection with C-111) to US Highway 1. A new pump station would also be constructed to pump excess floodwater from C-111 into the new canal. Water would overflow the canal banks and would sheetflow southward across the southern C-111E basin. The C-111E land area that would be impacted is currently owned by SFWMD. Existing culverts through the north levee along C-111 would pass water southward across C-111 and into ENP. The south C-111 levee between S-18C and S-197 would be removed as a part of this plan to facilitate southward flow.

5.6.2.2 Alternative B

Alternative B as shown in Figure 5-3 includes all of the features of alternative A, but would also include a new canal connecting C-111 (just north of S-177) to the L-31W borrow canal just south of S-175). The purpose of the canal would be to enable additional diversion of excess water to ENP. A determination would be made as to whether a structure in the canal would be required.

5.6.2.3 Alternative C

Alterative C as shown in Figure 5-4 would include all of the features of alternative A, and a new structure between S-18C and S-197. The purpose of the structure would be to hold higher upstream water levels to force more flow into ENP from the western portion of this canal section. Currently, the vast majority of flows to ENP are from the east end of the canal section near S-197.

5.6.2.4 Alternative D

Alternative D as shown in Figure 5-5 is identical to alternative A except that S-197 is never opened.

5.6.2.5 Evaluation of Preliminary Alternatives

As the preliminary alternatives were being evaluated, the project objectives were also being more clearly defined. Consequently, none of the plans were formulated to fully met the current objectives. ENP evaluations of the impacts of seepage from the headwaters and upper portions of Taylor Slough into the L-31N borrow canal emphasized the importance of restoration of these areas to the all of

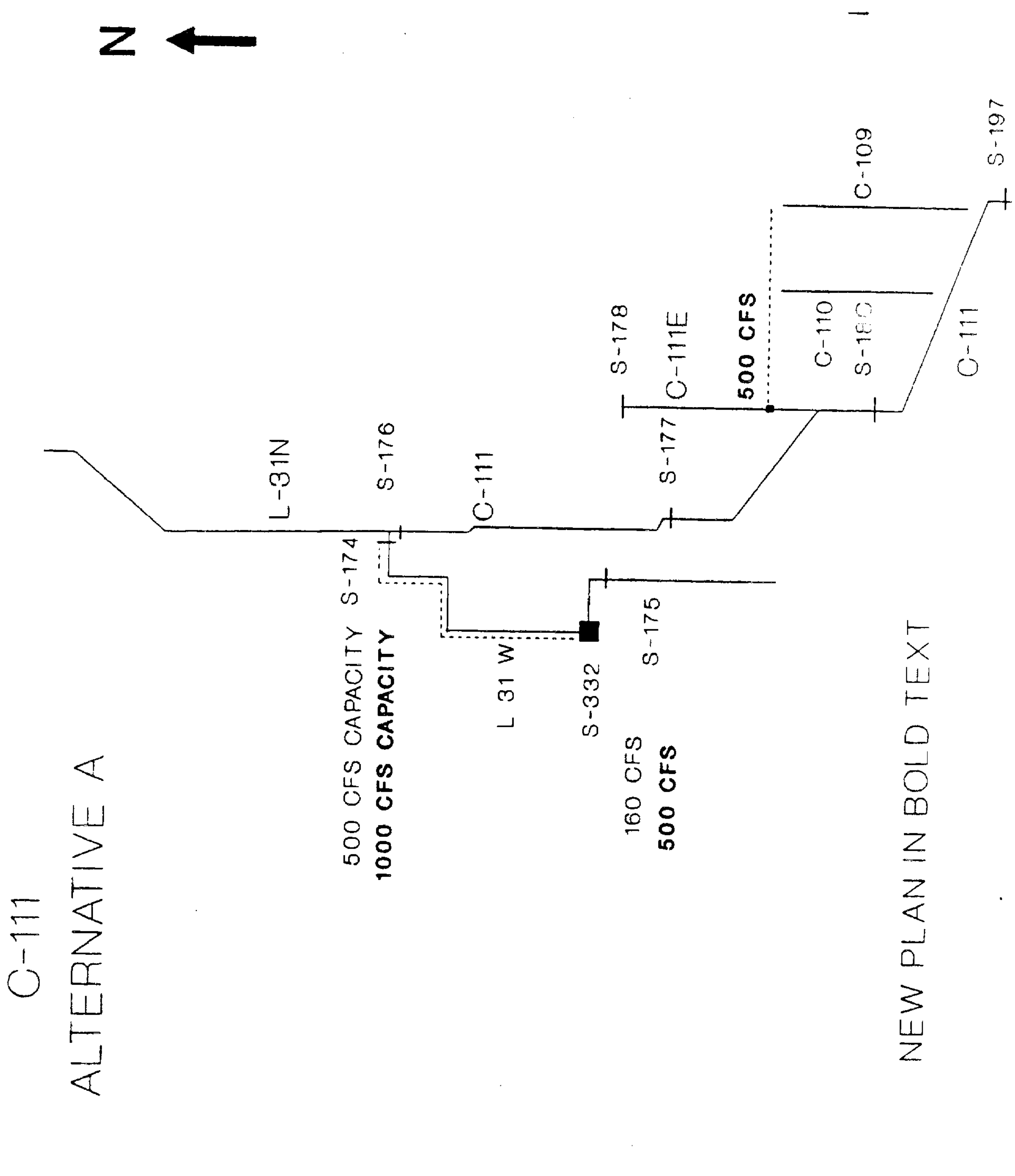

C-111
ALTERNATIVE A
N
L-31N
S-176
C-111
S-177
S-178
C-111E
500 CFS
C-110
S-18C
C-109
S-197
C-111
S-174
500 CFS CAPACITY
1000 CFS CAPACITY
L 31 W
S-332
S-175
160 CFS
500 CFS
NEW PLAN IN BOLD TEXT

FIGURE 5-2

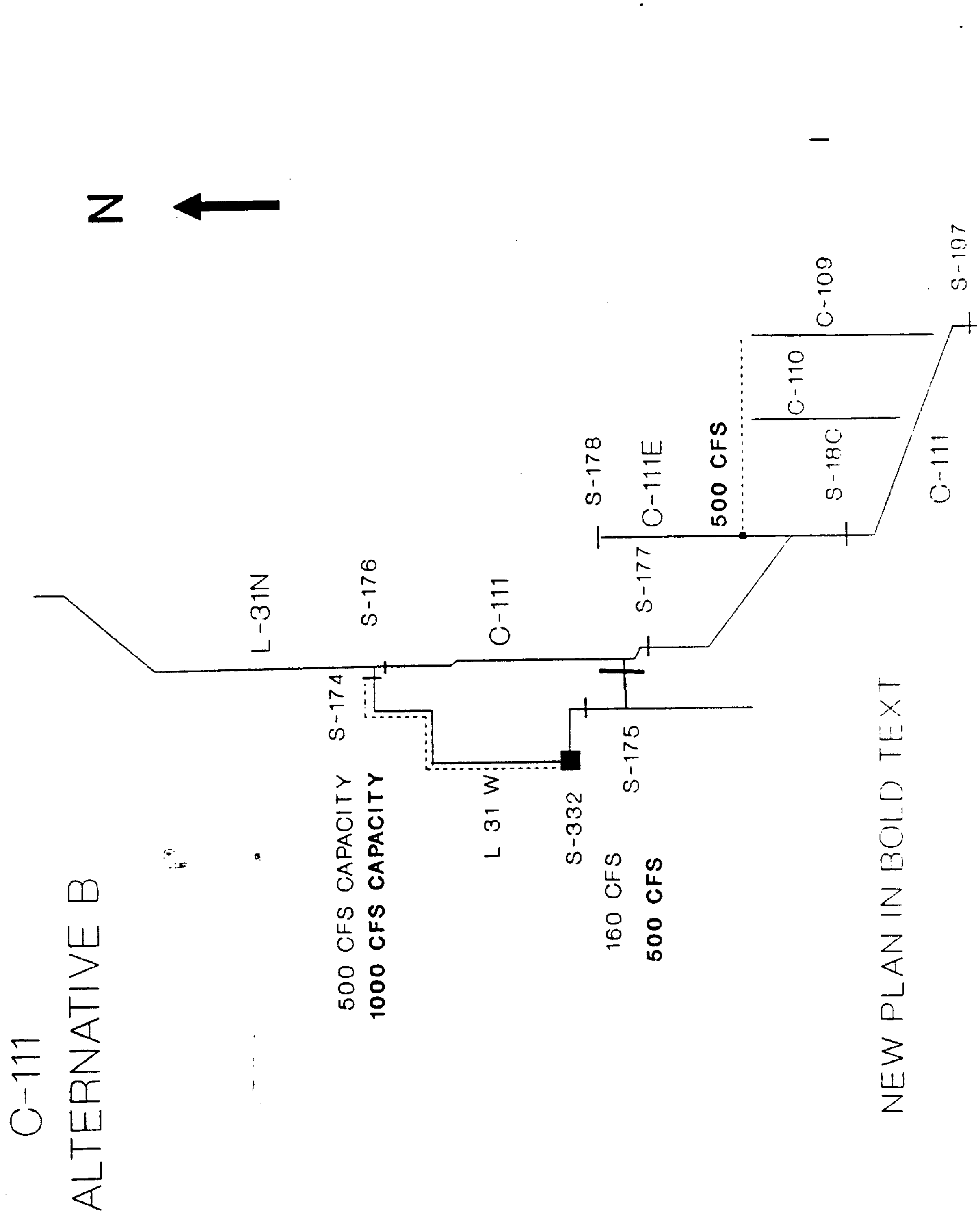

C-111
ALTERNATIVE B
N
L-31N
S-176
C-111
S-177
S-178
C-111E
500 CFS
S-18C
C-110
C-109
S-197
C-111
S-174
500 CFS CAPACITY
1000 CFS CAPACITY
L 31 W
S-332
160 CFS
500 CFS
S-175
NEW PLAN IN BOLD TEXT

FIGURE 5-3

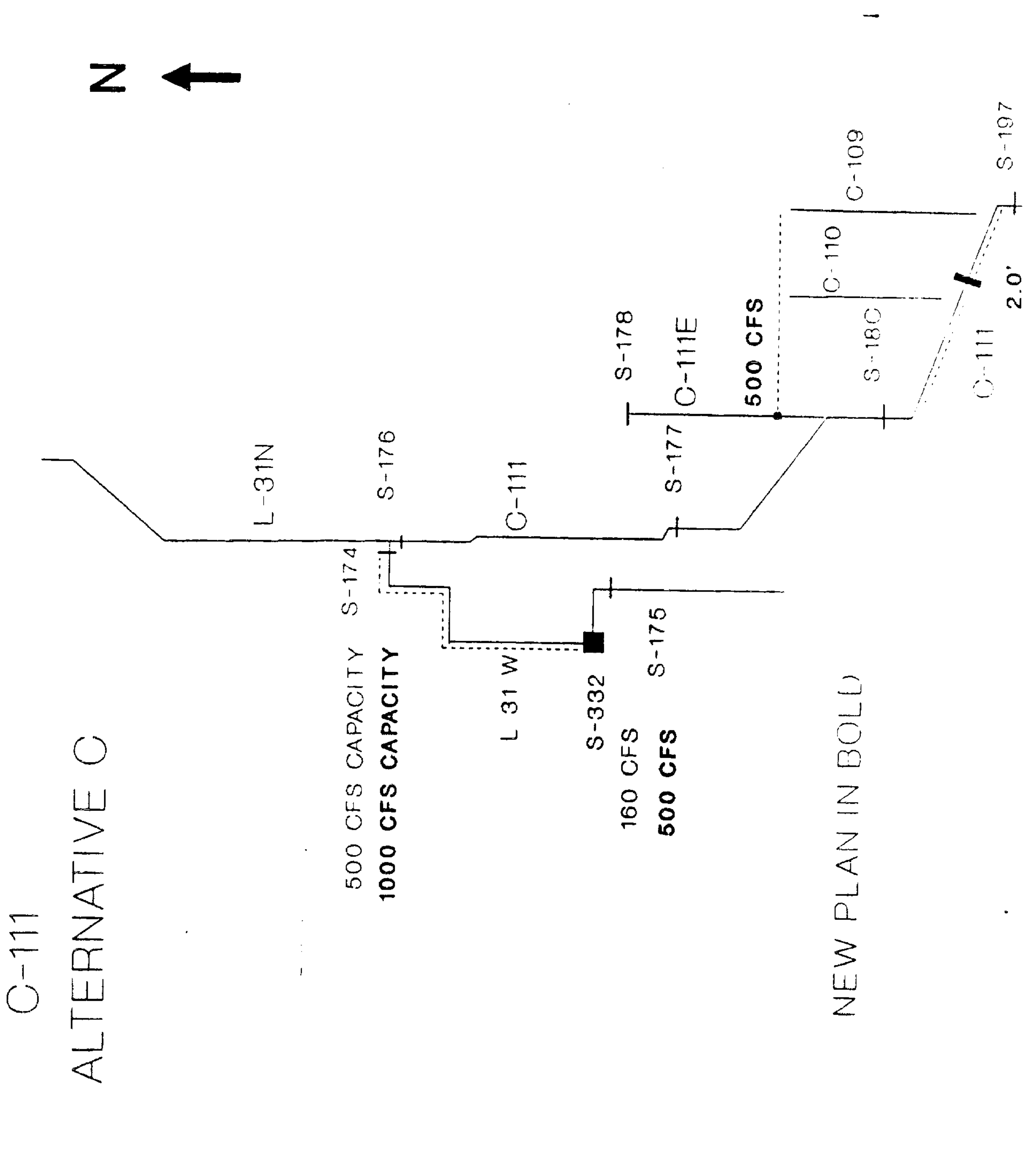
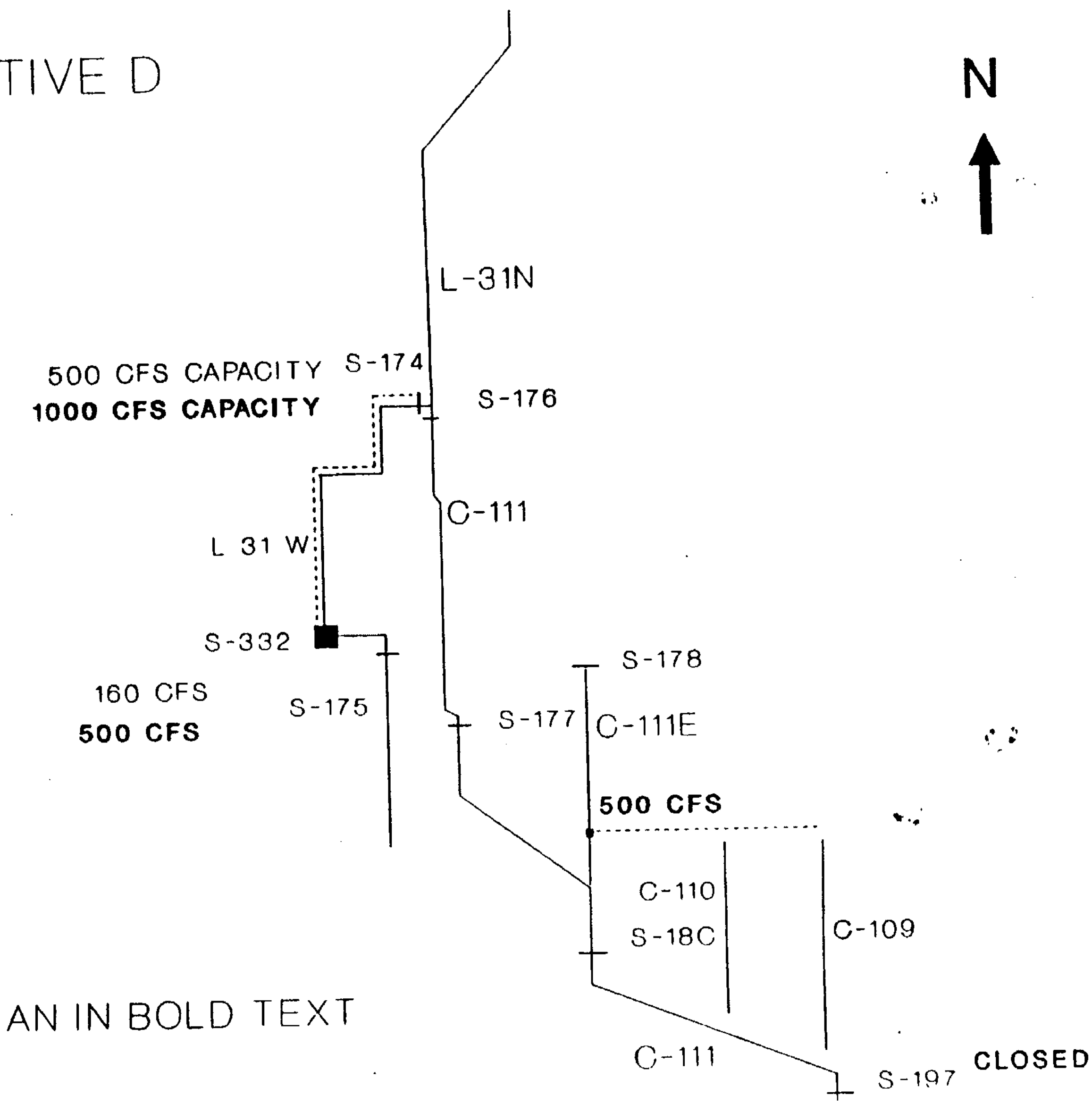

C-111
ALTERNATIVE C
N
L-31N
S-176
C-111
S-177
S-178
C-111E
500 CFS
C-109
C-110
S-18C
C-111
S-197
2.0'
S-174
500 CFS CAPACITY
1000 CFS CAPACITY
L 31 W
S-332
S-175
160 CFS
500 CFS
NEW PLAN IN BOLD

FIGURE 5-4

C-111
ALTERNATIVE D



NEW PLAN IN BOLD TEXT

FIGURE 5-5

Taylor Slough. In later phases of plan formulation, this became a major objective of hydrologic restoration.

All of the plans provided structural modifications that would restore large flows to the middle portion of Taylor Slough. All of the plans would provide alternative discharge capacity of floodwaters that would reduce the need for S-197 discharges to Manatee Bay/Barnes Sound. All of the plans would maintain flood protection in the C-111 basin. Also, all of the plans would provide for restoration of natural flows through the SFWMD wetlands east of C-111. However, the plans would maintain the L-31N borrow canal as the border between the ENP and agriculture. As a result, there would be continued groundwater seepage from the headwaters and upper portions of Taylor Slough into the canal. None of the plans provided a mechanism for reestablish of the natural timing and location of discharges to the headwaters and upper portions of Taylor Slough.

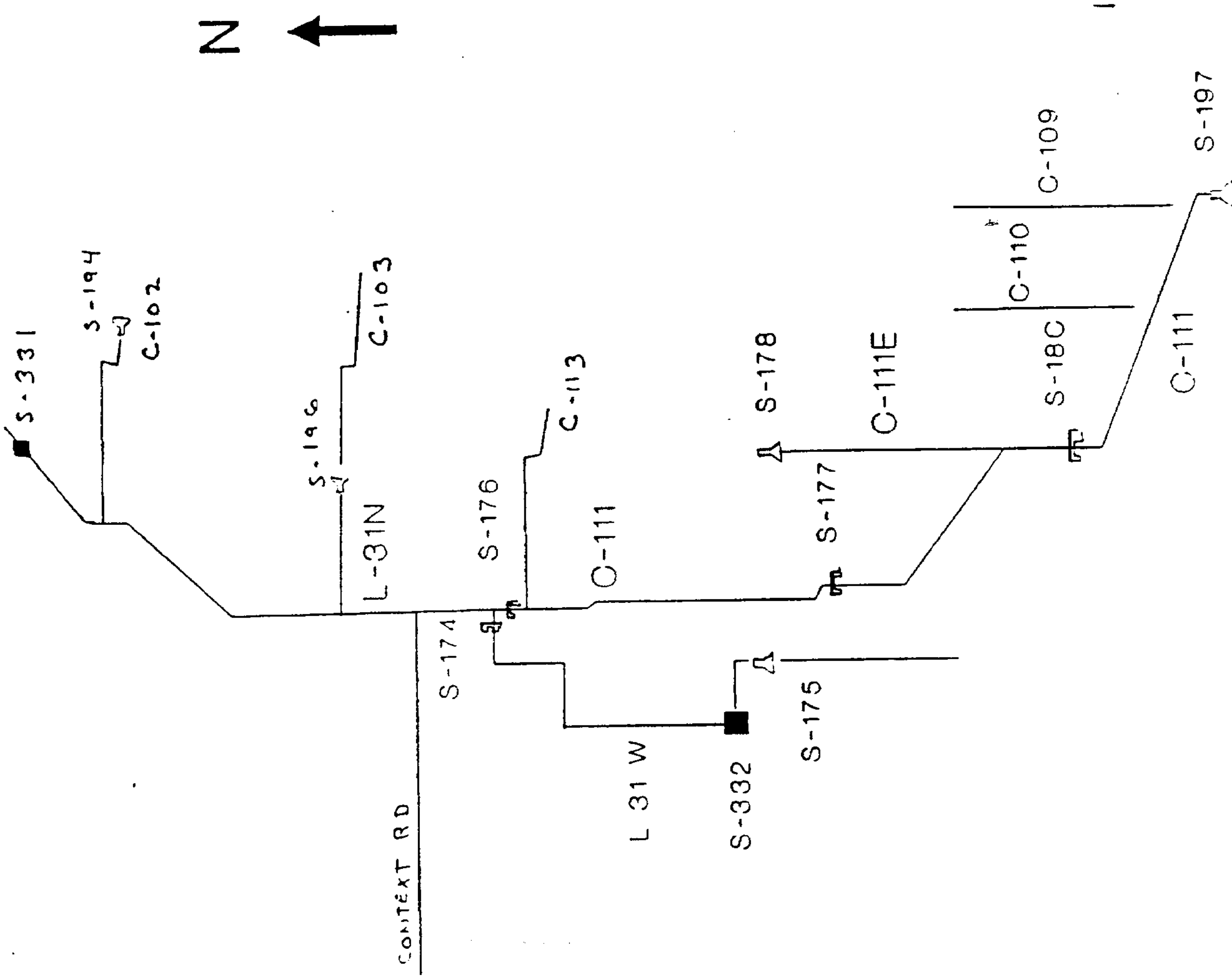
5.6.3 Refined Preliminary Plans

In March 1993, the Corps met with the SFWMD and the ENP to formulate new, more comprehensive alternatives to solve the problems identified within the C-111 basin. The objective of the meeting was to scope various alternatives which would provide full restoration to that portion of the Everglades National Park adjacent to the C-111 study area, while maintaining the overall objectives of the reevaluation report. A total of twelve conceptual project components were proposed. Five alternative plans were formed by combinations of the various plan components. These alternative plans are discussed below. Additional features including a low flow pump at Context Road to rehydrate upper Taylor Slough, and the enlargement of Loveland Slough to provide additional water to the east-west spreader canal area were also discussed as possible measures for evaluation.

5.6.3.1 Plan 1

This was considered a non-structural plan which called for only operational changes to system management. The project would be operated to maintain the design optimum conditions as described in Section 2.2.1.2. This plan is shown in Figure 5-6.

Optimum and design water levels in the project canals are established on the basis of desirable water control conditions in each area, i.e., optimum groundwater levels, intake and/or discharge structure elevations and removal rates for flood control. Along the east coast salinity control is included as a requirement of canal-level design criteria. Optimum water levels in the project canals are periodically adjusted based on operating experience, changed land uses and to better meet project objectives and changing conditions.



PLAN 1
C-111

FIGURE 5-6

5.6.3.2 Plan 2

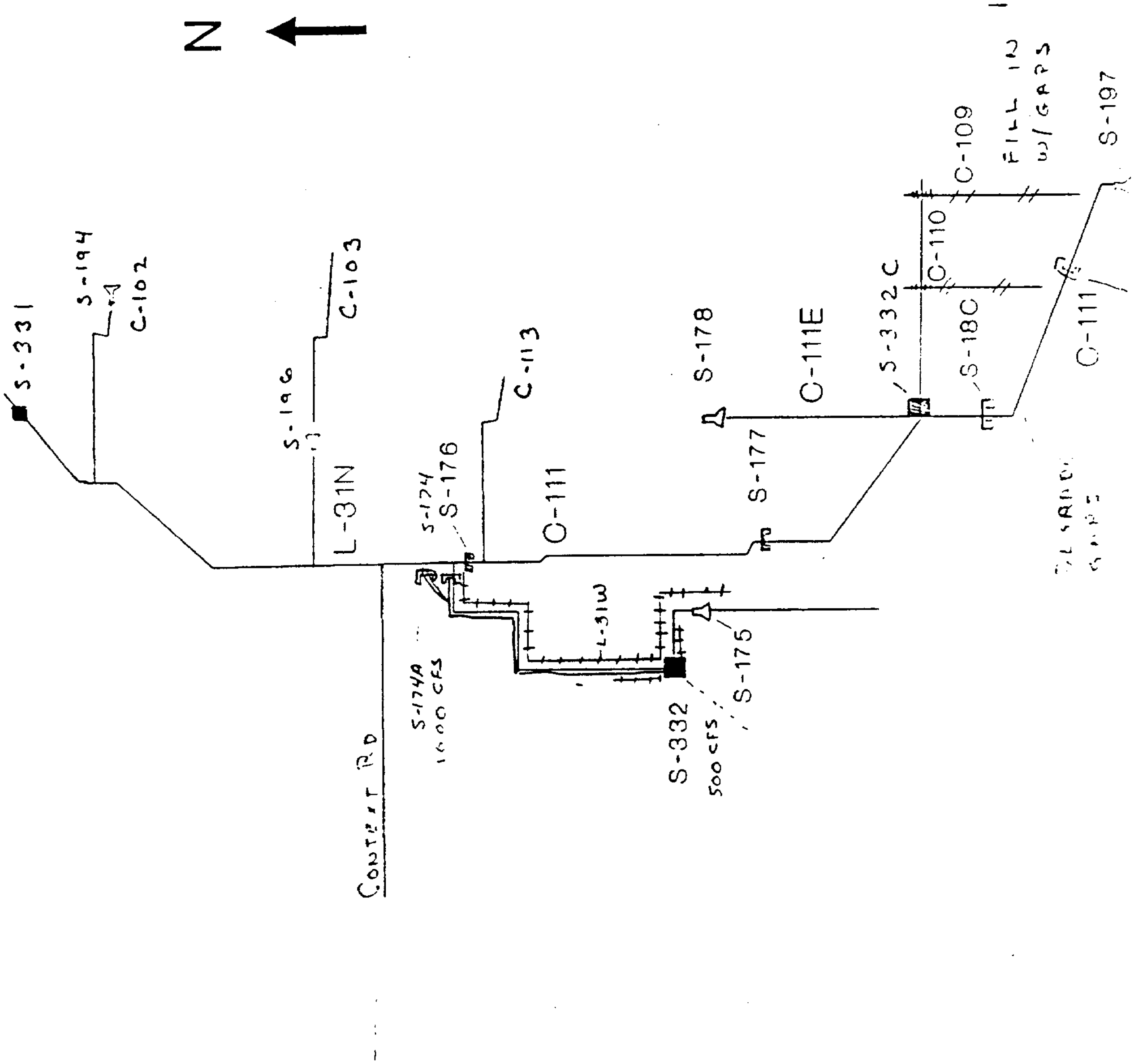
Plan 2 would similarly maintain the design optimum canal stages, however structural modifications are proposed to provide flow to Taylor Slough. This plan has been subdivided into plans 2A and 2B which increase capacities of pump structures S-332, and S-174. Both plans call for the construction of an East-West spreader canal,and a 2-mile trapezoidal channel just south of Context Road. Also contained in both plans is a trapezoidal canal through Loveland Slough which will include a new gravity flow structure designed to pass 500 cfs. This plan would remove structure S-178. Details of plans 2A and 2B are shown in Figure 5-7 and Figure 5-8, respectively.

5.6.3.3 Plan 3

Plan 3, as with plan 2, maintains design optimum canal stages and calls for structural modifications for improved water deliveries. This plan, however, includes acquisition of the western Frog Pond. As with plan 2, plan 3 includes the East-West Spreader Canal, the Context Road Channel, and the Loveland Slough Canal. Plan 3 has also been subdivided into plans 3A and 3B which assess 500 cfs and 1,000 cfs structure capacities, respectively, associated with a new canal from L-31N to L-31W just north and west of structure S-174. Plans 3A and 3B would fill L-31W north leg, and east of structure S-332. The S-332 pumps would be removed. Plans 3A and 3B are shown in Figure 5-9 and Figure 5-10, respectively.

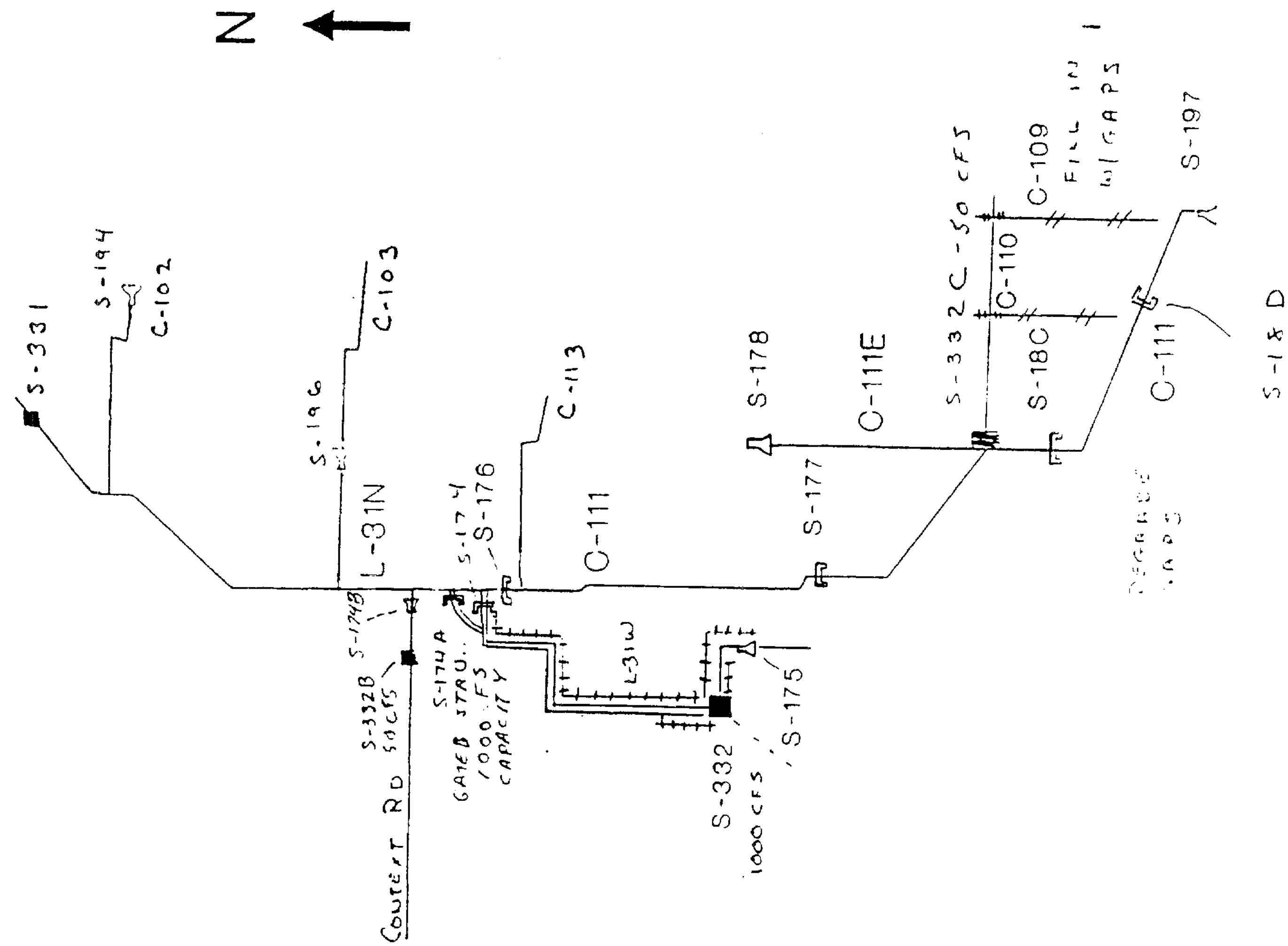
5.6.3.4 Plan 4

Plan 4 as shown in Figure 5-11 includes the construction of a surge pool on the east side of the Frog Pond. Culverts would pass flows from the surge pool into and out of the Frog Pond. Also included in this plan is a 1630 cfs pump station at S-174, and a new structure between S-18C and S-197. Levees downstream of C-111E would be degraded. It is expected that ground water in the surge pool would flow east into C-111, possibly adversely affecting the current levels of flood damage reduction provided to the agricultural area east of C-111 and the Frog Pond.



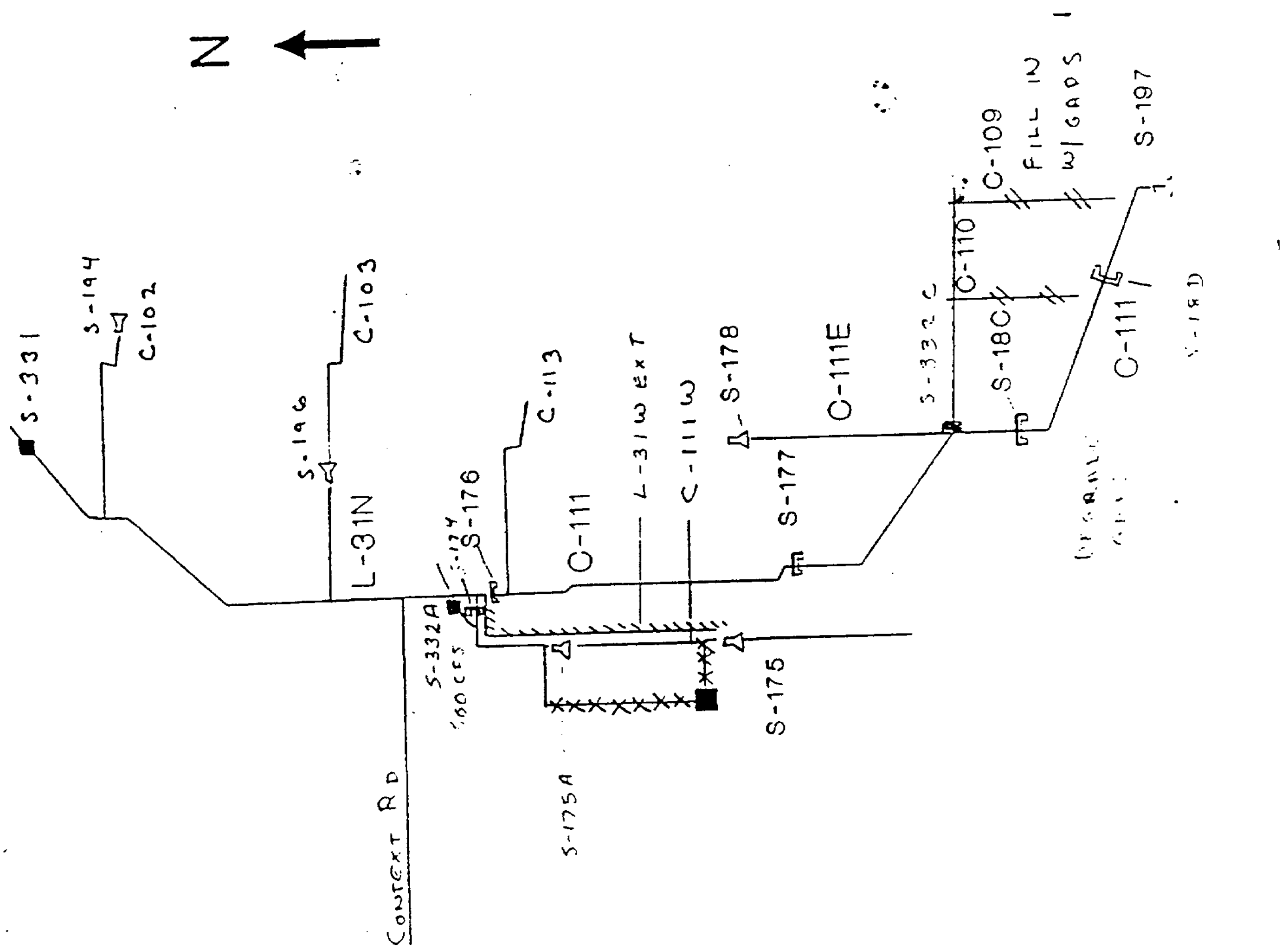
PLAN 2A
C-111

FIGURE 5



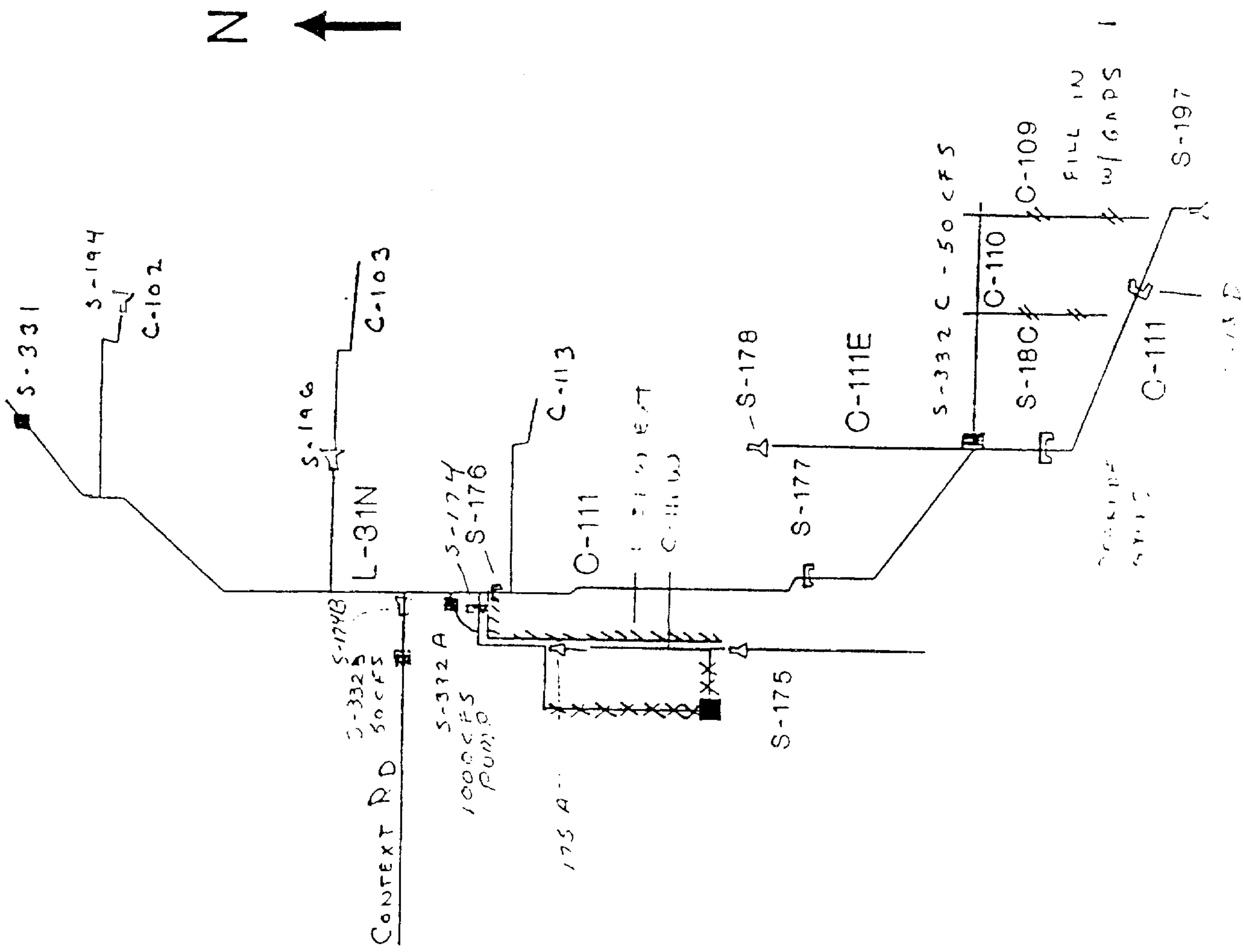
PLAN 2
C-111

FIGURE 5-8



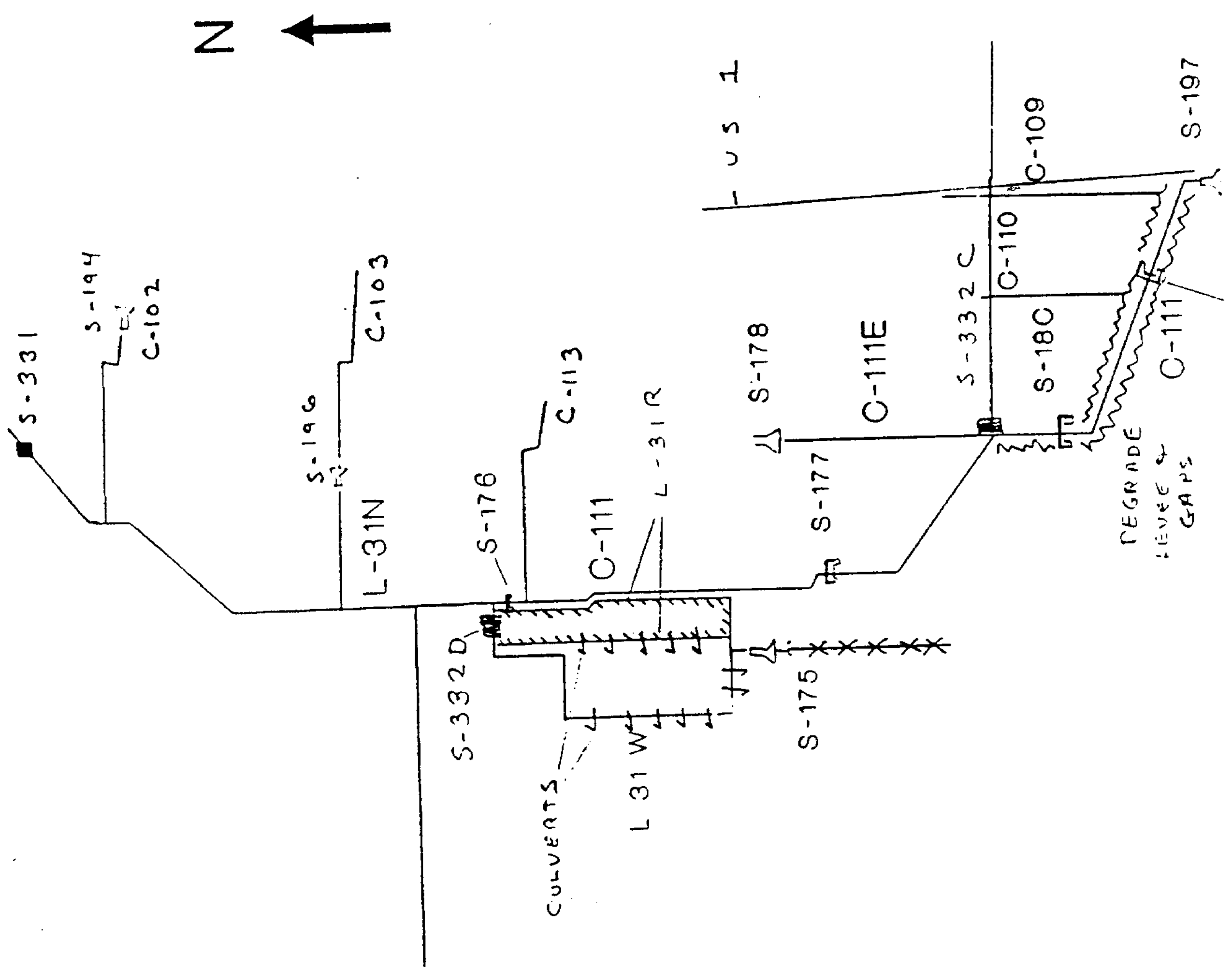
PLAN 3A
C-111

FIGURE 5



PLAN 3B
C-111

FIGURE 5-10



PLAN 4
C-111

FIGURE 5-11

Table 5-1
Refined Preliminary Alternatives

Plans	ISSUES AND CONCERNS						
	Operational Flexibility	"Full" Restoration	Reduced Flow to Manatee Bay/Barnes Sound	Cost (Lands)	Cost (Construction)	Flood Control	Florida Bay Improvement
1	0	+	0	+	+ +	-	+
2A	+	+	+	+	-	+	+
2B	+	+	+	+	-	+	+
3A	+	+	+	-	=	+	+
3B	+	+	+	-	=	+	+
4	+	+	+	-	= -	?	+
5	=	+ +	+ +	= =	-	0	+
Context Road	+	+	+	-	-	+	+
Loveland Slough	+	0	0	-	-	+	+

LEGEND:

+ Good

\- Bad

0 No Change

5.6.3.5 Plan 5

Plan 5 as shown in Figure 5-12, is the "Full Restoration" plan and returns the system back to natural conditions. This plan would cease operations of existing structures and backfills all canals below structure S-331. Canals C-102, 103, and 113 would be backfilled in those portions west of the divide structure. This plan basically eliminates the means to provide water conveyance for any purpose.

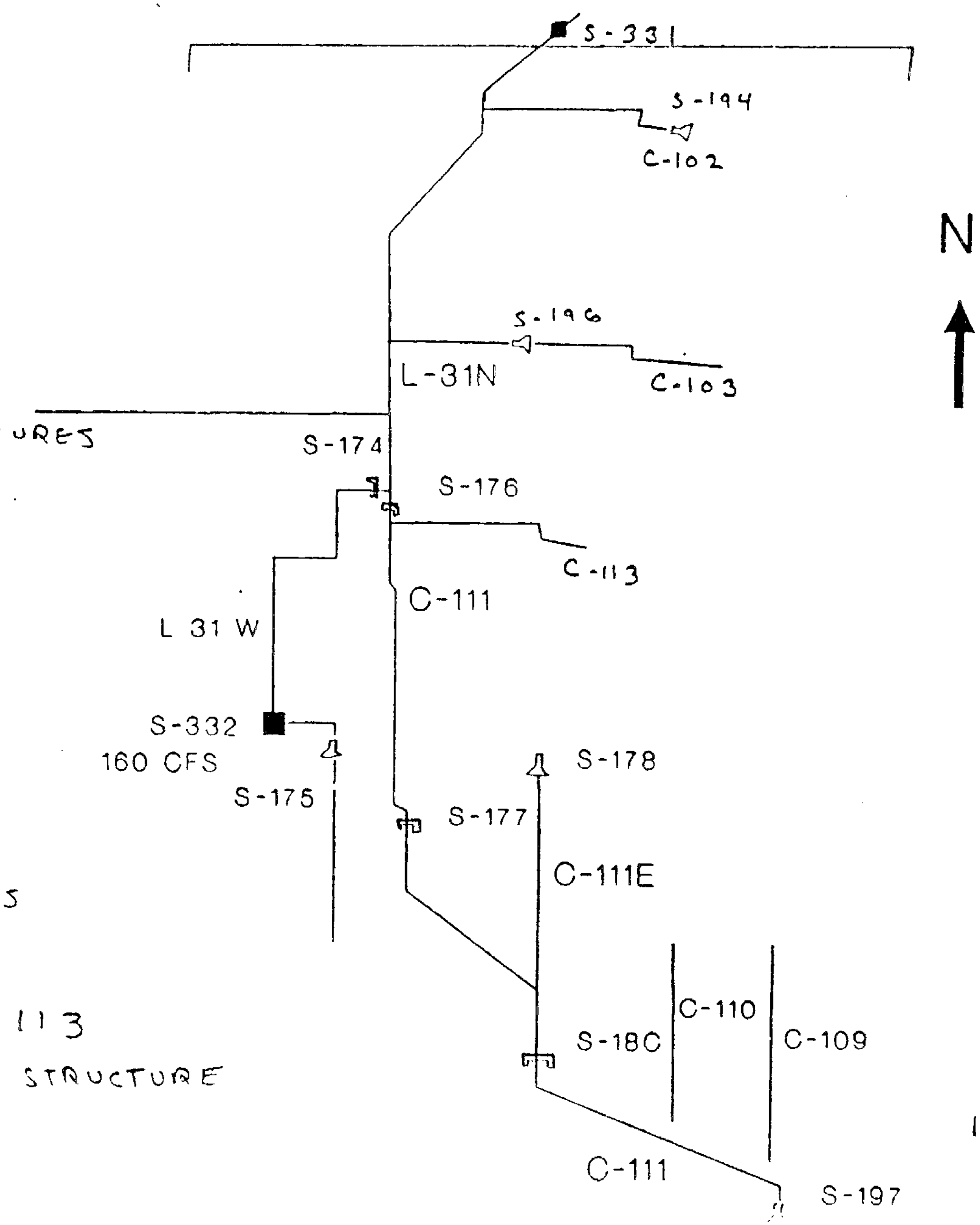
5.6.3.6 Evaluation

The group members at the March 1993 meeting rated the alternatives in terms of issues and concerns and this is presented in Table 5-1. No firm data existed for the alternatives, but experience working in the area was utilized for the analysis. Other additional alternatives were added as shown in Figure 5-13, like Loveland Slough bypass and a low flow pump at Context Road. Loveland Slough was dropped from consideration since there was concern over future operating criteria that would flood agricultural interests adjacent to the slough and there was no support.

Issues and concerns were items that the group decided would be important to the overall selection of a plan. These areas were: operational flexibility, full restoration, minimum flow to Manatee Bay/Barnes Sound, the cost of lands, cost of construction, flood control and Florida Bay improvements.

Operational flexibility was used in terms of movement of flood water or minimum deliveries to various parts of the basin. Full restoration was the idea of what the Everglades system was considered to be like before the C&SF canals were constructed. Reduced (minimum) flow to Manatee Bay/Barnes Sound was addressed through the operation of S-197. The cost of lands were considered due to the large areas which would be required as a project cost. The cost of construction is always considered and is usually proportional to the scope of construction features included in the plan. Flood control was evaluated for neighboring agricultural activities. Florida Bay was not a direct objective to the study, however, the restoration of more natural fresh water flows Taylor Slough and C-111 would eventually benefit Florida Bay.

The team members subsequently consulted with their respective offices to arrive at a consensus on the final array of plans to be evaluated. As a result of this consensus, plan 1 was designated as the "no-action" plan as it consisted of no structural modifications. Plan 2A was dropped in favor of plan 2B, since plan 2B provided more capability of fresh water to Taylor Slough than plan 2A. Plan 3B was chosen over plan 3A for the same reason as plan 2B over 2A. Plan 4 was retained for further study. Plan 5 was dropped since this plan ceases all operations of structures and fills in all the canals, and basically eliminates any means to provide any additional water.



1. No Operation of Structures

S-174	S-18C
S-175	S-194
S-176	S-196
S-177	
S-178	
S-197	

2. Backfill All Canals below S-331.

3. Backfill C-103, 102, 113 west of Divide Structure

PLAN
C-111

FIGURE 5-12

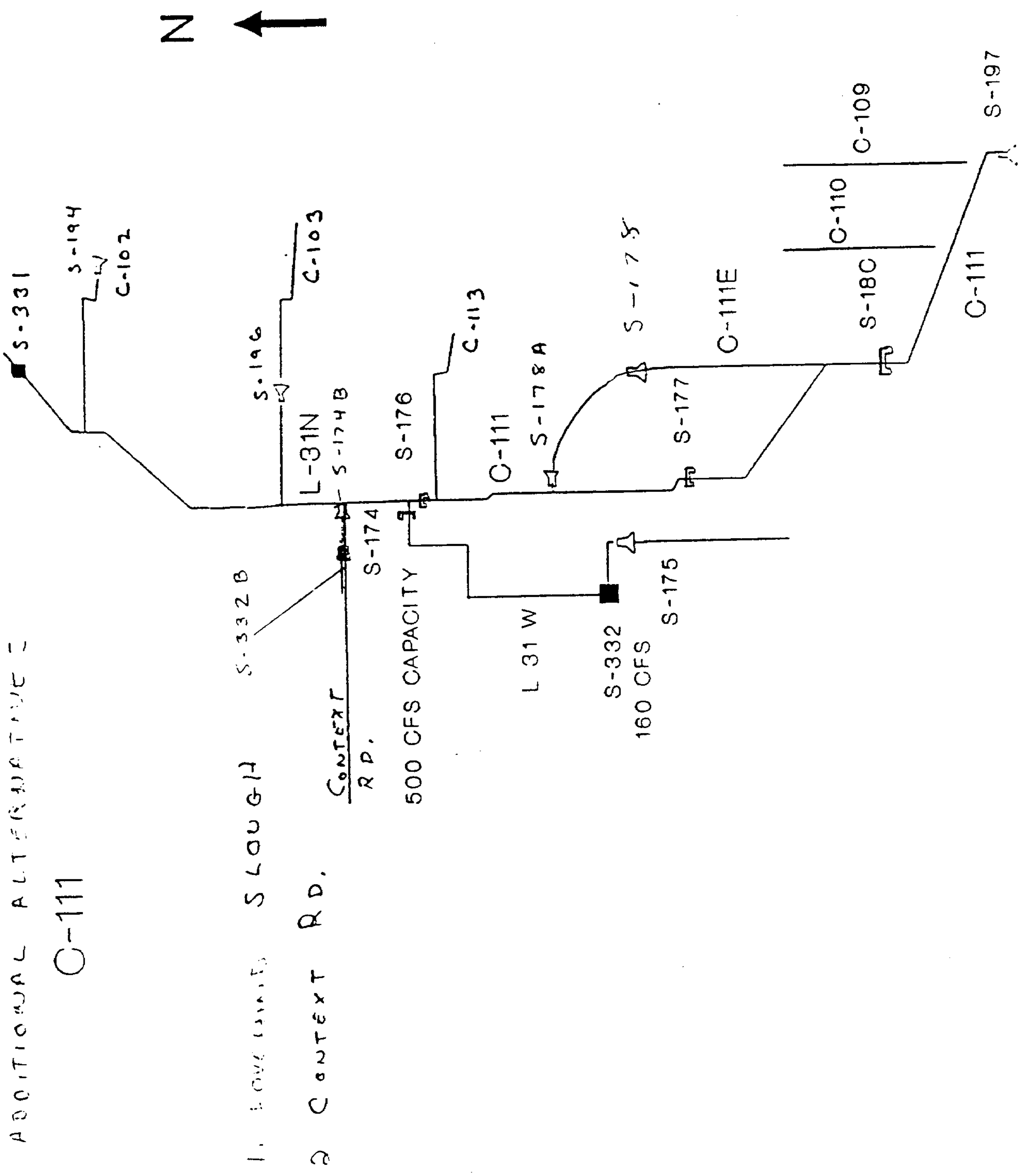

ADDITIONAL ALTERNATIVE
C-111
1. SLOUGH
2. CONTEXT RD.
N
S-331
S-194
C-102
C-103
S-196
L-31N
S-174B
S-176
C-113
C-111
S-178A
S-175
S-177
C-111E
C-110
C-109
S-18C
S-197
C-111
S-332B
S-174
CONTEXT RD.
500 CFS CAPACITY
L 31 W
S-332
160 CFS
S-175

FIGURE 5-13

5.6.4 Final Alternatives

The final array of alternatives evolved through further discussions with study participants. Preliminary alternative plans were reassessed and modified for evaluation as a means of selecting a recommended plan of action to meet the study objectives. For the final assessment, plan 1 became the "no action" alternative, plan 2B became alternative 1, plan 3B became alternative 2, and plan 4 became alternative 3. Minor modifications deleted the structure on the lower end of C-111 in alternative 1 and 2, due to cost. The staff at the ENP recommended another plan, alternative 4, and the staff at the SFWMD recommended another plan, alternative 5. Additional refinements were made to alternative 4 to produce alternative 6 and alternative 1A is a refinement of alternative 1.

Alternative 8 was recommended for consideration by ENP as a result of their evaluation of hydrologic impacts of alternatives 1 through 7 (see Annex F). Alternative 7 is a modification of alternative 1 and has been renamed alternative 1A. Alternative 6A was developed as an refinement of alternative 8. Alternative 9 was added at the suggestion of south Dade County agricultural interests.

These plans were modeled using the most current version of the South florida Water Management Model (SFWMM) one mile by one square mile model with the existing canals and structures operating at the design optimum level prior to the interim tests. Pumping rates for the West Dade Wellfields were assumed at 40 million gallons per day and applied to the program. The final alternatives are discussed in the following paragraphs. All alternatives wee designed to provide approximately the same level of flood protection.

5.6.4.1 "No Action" Alternative

The "no action" alternative would consist of reverting back to the minimum delivery schedule. That is: discontinue the experimental deliveries to Northeast Shark River Slough, return to the minimum delivery schedule for deliveries to ENP, and return canal stages to their optimum design levels. The ENP and other resources agencies have determined that detrimental impacts to the ecosystems of the ENP have occurred as a result of the minimum water delivery schedule.

This alternative is the same as the future "without project" condition. It is also referred to as the base condition.

5.6.4.2 Alternative 1

The objective of alternative 1 as shown in Figure 5-14, is to put as much water as possible into Taylor Slough while avoiding impacts to the agricultural areas in the Frog Pond. A new canal, designated Context Road Canal, and a new pump station, S-332B, would be located upstream of S-176 and west of L-31N borrow canal. The 50 cfs pump station would divert water from L-31N borrow canal to Context Road canal. Water would sheet flow from the Context Road canal southward into the headwaters of Taylor Slough and to Everglades National Park. This was intended to address the project objective of restoring natural hydrologic conditions in the headwaters and upper portions of Taylor Slough.

Adjacent to existing S-174, a new, slide-gated structure designated S-174A would provide for a combined discharge to L-31W borrow canal of 1,500 cfs. The L-31W borrow canal capacity would be increased to convey 1,500 cfs to S-332. S-332 would be enlarged to a pump station consisting of six pumps with a total discharge capacity of 1,000 cfs. Tieback levees adjacent to S-332 would prevent flow back into L-31W. A discharge channel on the downstream side of S-332 would provide conveyance away from the pump. These project features were intended to address the project objective of maintaining flood control by providing additional outlet capacity of flood waters into Taylor Slough. They also apply toward the project objective of restoring more natural flows to the middle portion of Taylor Slough.

A new canal would be constructed in the lower C-111 area to supply water for environmental restoration of the area served by C-109 and C-110. The new canal, the east/west spreader canal, would receive water from C-111E via a 50 cfs pump and provide conveyance east across canals C-109 and C-110. C-109 and C-110 would be plugged with material from spoil banks remaining along both sides of each canal. Nine plugs, each about 200 feet long, would be constructed up to ground level in C-109, and ten plugs in C-110. To allow overland flow from east to west and to prevent water from entering the unplugged canal sections, the spoil banks remaining at the end of each plug would be connected. Together, these features were intended to address the project objective of restoring more natural overland flows and water conditions in the east/ west spreader canal lands.

A large mound of material excavated in the construction of C-111 remains on the canal's south bank. The spoil mound would be leveled to natural ground to allow sheet flow southward. This would address the project objective of reducing S-197 flood discharges to Manatee Bay/Barnes Sound. Flood discharges at S-18C would more efficiently spill over the southern bank of C-111, thereby reducing the need for passing these flows through S-197. Additionally, the increased capacity to discharge floodwaters through the L-31W borrow canal and S-332 would also reduce the need to utilize S-197.

5.6.4.3 Alternative 1A

Alternative 1A, as shown in Figure 5-15, is very similar to alternative 1, but eliminates the east-west spreader canal. This alternative is single purpose flood

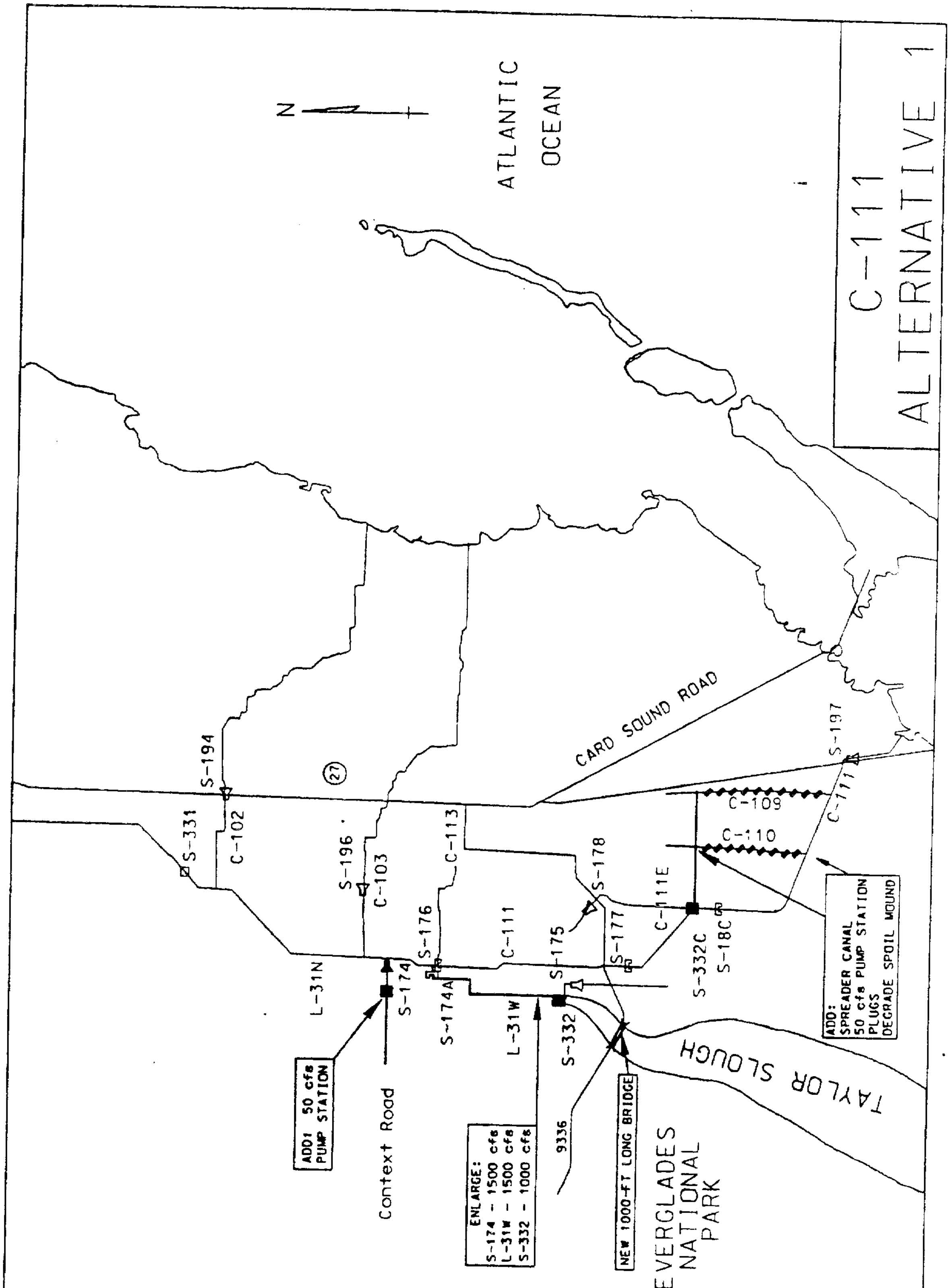

C-111
ALTERNATIVE 1
N
ATLANTIC
OCEAN
CARD SOUND ROAD
S-194
27
S-331
C-102
S-196
C-103
C-113
S-176
S-174
S-174A
C-111
S-175
S-177
S-178
C-111E
S-332C
S-18C
C-109
C-110
C-111
S-197
L-31N
L-31W
S-332
9336
ADD: 50 cfs
PUMP STATION
Context Road
ENLARGE:
S-174 - 1500 cfs
L-31W - 1500 cfs
S-332 - 1000 cfs
NEW 1000-FT LONG BRIDGE
EVERGLADES
NATIONAL
PARK
TAYLOR SLOUGH
ADD:
SPREADER CANAL
50 cfs PUMP STATION
PLUGS
DEGRADE SPOIL MOUND

FIGURE 5-14

control alternative, in that, the pump at S-332 is utilized for flood control purposes. There are no water supply features to this plan. Other than the east-west spreader canal, plugs and spoil mounds, which are not included in this plan, it is the same as alternative 1.

This plan was designed for flood control only to determine the least cost flood control alternative. This plan was not analyzed for environmental outputs and benefits, since it is an unsupported environmental plan.

There are no separable elements with alternative 1A. While the pump stations provide water supply to the ENP, their primary function is to provide the necessary flood protection to the agriculture community.

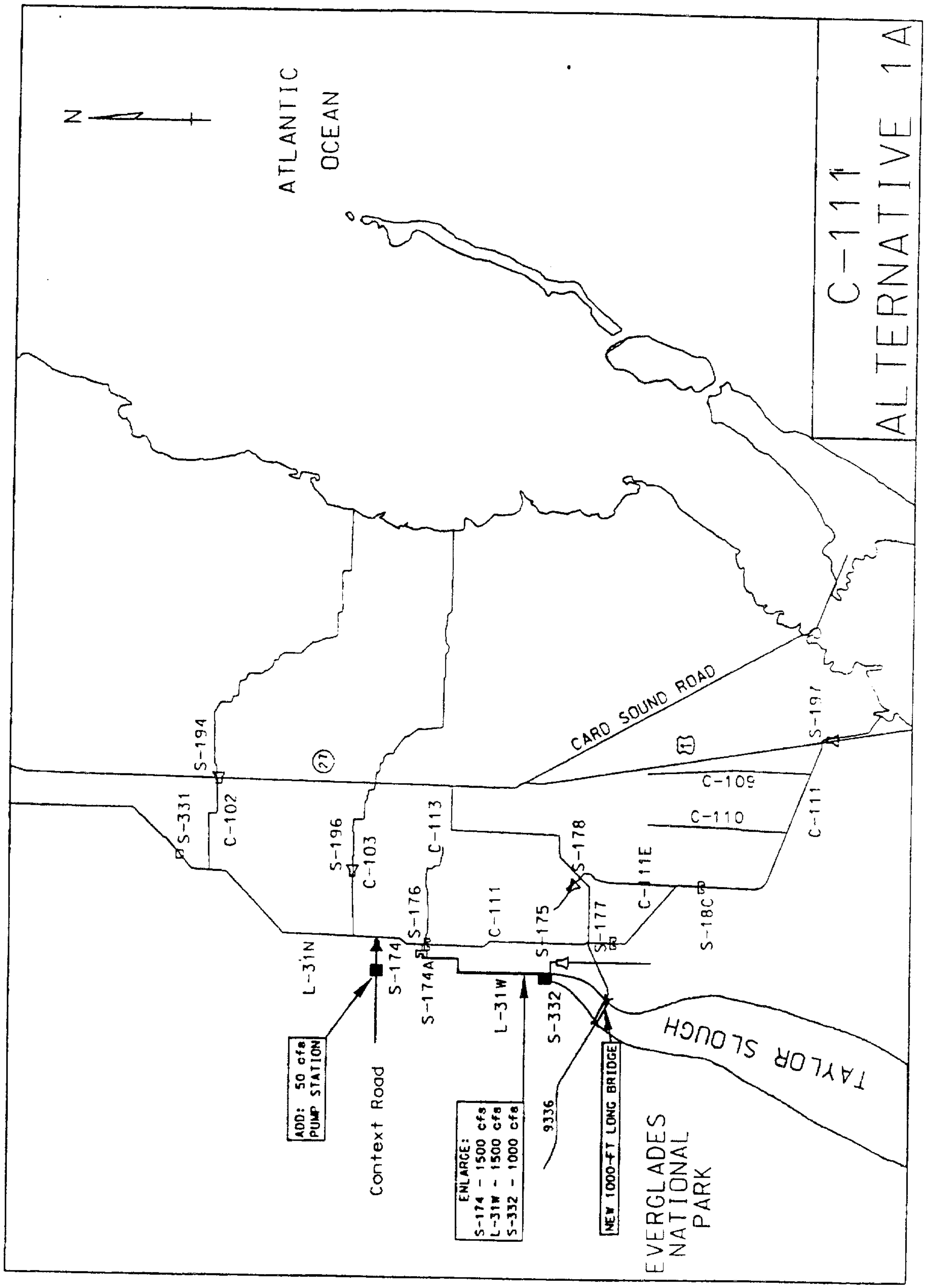
5.6.4.4 Alternative 2

Alternative 2, as shown in Figure 5-16, would have the objective of delivering more water to Taylor Slough and its headwaters and restoring sheet flow to the lower canal area. In common with alternative 1, the Context Road structures and the spreader canal, plugs, and gapped lower C-111 disposal mound would be used. Differences include the impact on the Frog Pond, partial filling of L-31W borrow canal, abandonment of S-332, provision of a new pump station, S-332A, and a new levee and borrow canal, L-31W Extension.

The Context Road and east/west spreader canal was intended to address the project objective of restoring natural hydrologic conditions in the headwaters and upper portions of Taylor Slough.

Flood water in excess of the capacity of the proposed Context Road pump station and canal would be pumped from L-31N borrow canal to L-31W borrow canal by a new pump station that would be constructed adjacent to the S-174 gated spillway. The new pump station, S-332A, would include 6 pumps with a total discharge capacity of 1,000 cfs.

L-31W would be extended directly southward (L-31W Extension) across the Frog Pond from the north to S-175, on the south. The portion of L-31W that forms the western and southern borders of the Frog Pond would be degraded to fill the L-31W borrow canal in that reach, and S-332, at the point where L-31W crosses Taylor Slough, would be abandoned. The effect would be that of moving a 3-mile, north-south segment of the L-31W canal and levee about one mile eastward. Passage of water into the new borrow canal would be controlled by a new, slide-gated culvert, S-175A, capable of passing 500 cfs. The part of the Frog Pond that would be isolated west of L-31W Extension would be purchased for the project.



N
ATLANTIC
OCEAN
C-111
ALTERNATIVE 1A
CARD SOUND ROAD
S-197
S-194
S-331
C-102
S-196
C-103
C-113
S-176
C-111
S-174
S-174A
L-31N
L-31W
S-175
S-177
S-178
C-111E
S-18C
C-109
C-110
C-111
S-332
9336
TAYLOR SLOUGH
ADD: 50 cfs PUMP STATION
Context Road
ENLARGE:
S-174 - 1500 cfs
L-31W - 1500 cfs
S-332 - 1000 cfs
NEW 1000-FT LONG BRIDGE
EVERGLADES NATIONAL PARK

FIGURE 5-15

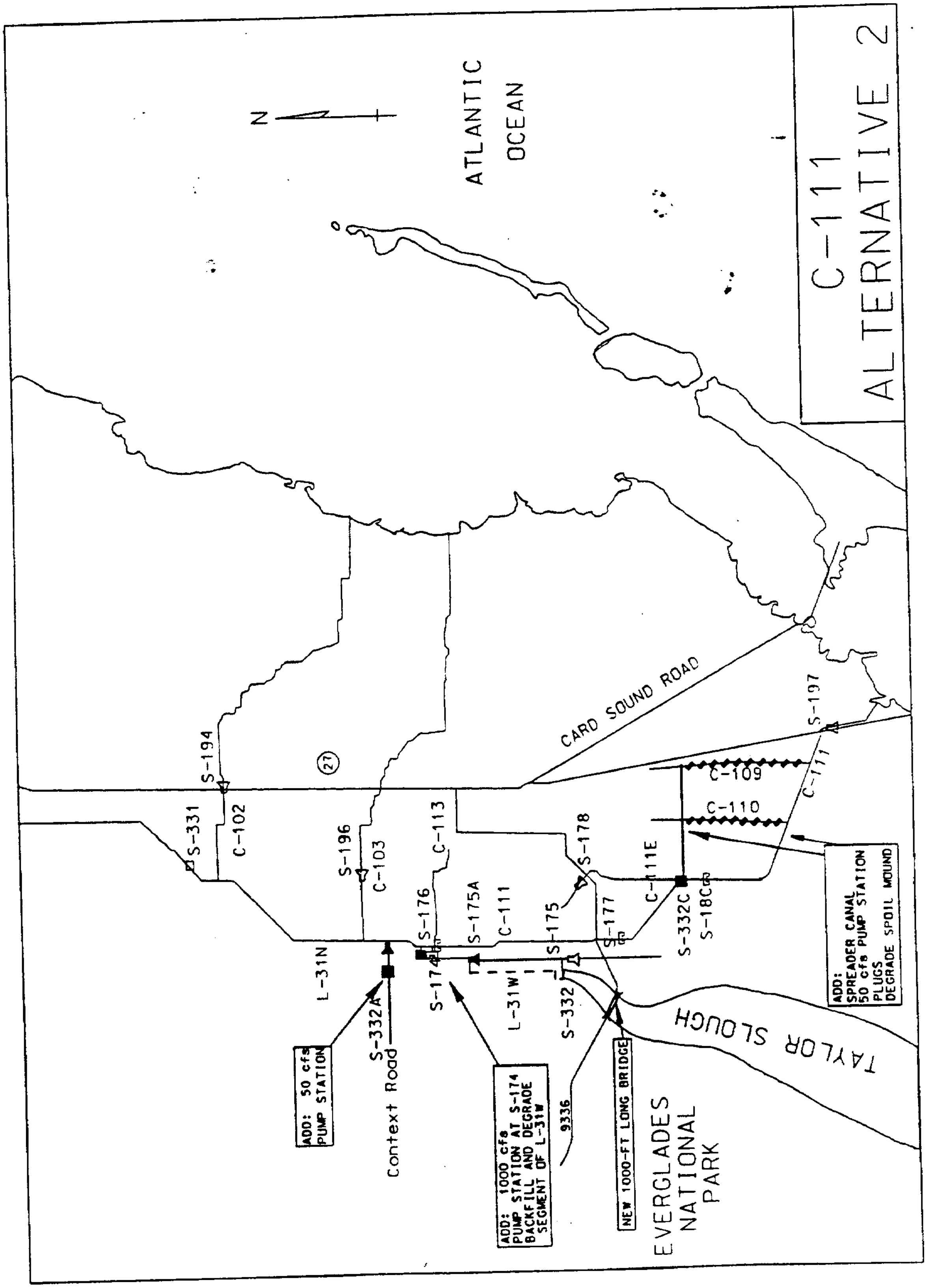

C-111
ALTERNATIVE 2
N
ATLANTIC
OCEAN
CARD SOUND ROAD
27
S-194
S-331
C-102
S-196
C-103
C-113
S-178
C-111E
S-332C
S-18C
C-109
C-110
C-111
S-197
S-176
S-175A
C-111
S-175
S-177
L-31N
S-174
L-31W
S-332
S-332A
Context Road
9336
TAYLOR SLOUGH
EVERGLADES
NATIONAL
PARK
ADD: 50 cfs PUMP STATION
ADD: 1000 cfs PUMP STATION AT S-174 BACKFILL AND DEGRADE SEGMENT OF L-31W
NEW 1000-FT LONG BRIDGE
ADD: SPREADER CANAL 50 cfs PUMP STATION PLUGS DEGRADE SPOIL MOUND

FIGURE 5-16

The L-31W features would address the project objective of maintaining flood control by providing additional flood discharge capacity. They would also apply toward the objective of restoring natural flows to the middle portion of Taylor Slough. Additionally, these features would provide an alternative flood control discharge capacity that would reduce the need for S-197 discharges.

In the lower canal area, the spreader canal, a 50 cfs pump station (S-332C), plugs in C-109 and C-110, and degradation of the disposal mound south of C-111 would provide overland flow into the Eastern Panhandle of the park. This would address the project objective of restoring natural flows and water conditions in SFWMD wetlands east of C-111.

5.6.4.5 Alternative 3

Alternative 3 provides for flood water retention and settling in a detention pool and storm water detention area, which would be constructed in the Frog Pond. The spreader canal feature in the lower canal area would be augmented by filling C-111 between S-18C and S-197. C-109 and C-110 would be plugged as in the first two alternatives. The Context Road features are not part of alternative 3. The detention pool and storm water detention area (SDA) are shown as alternative 3 in Figure 5-17. The detention pool would be formed by constructing a new levee directly south across the Frog Pond from L-31W on the north side to S-175 on the south, and constructing closure on the south between L-31W and C-111. The new levee and L-31W would enclose the storm water detention area to be located on the west side of the reservoir. The L-31W borrow canal would be filled on the south from S-332 to its terminus downstream of S-175. S-332 and S-175 would no longer be used.

Normal discharge of waters to the detention pool would be via a new pump station adjacent to S-174. The new pump structure, designated S-332A, would have a capacity of 1,630 cfs and would be operated in conjunction with S-174. A range of flows from low to flood could be alternatively routed (a) through the L-31W borrow canal to outflow overland from near the northwest corner of the pool, and/or (b) through S-332A into the pool.

Additional pump capacity at S-332A would address the project objective of maintaining flood control discharge capacity. Furthermore, the pump capacity was designed to divert all flood discharges that would otherwise be discharged into the lower C-111 via S-176. This addresses the project objective of reducing the need for S-197 food discharges. The detention pool addresses the objective of providing more natural timing of water deliveries to Taylor Slough. Excess water could be temporarily stored in the area and released in the desired rates.

Normal discharge from the detention pool to the detention area would be through 10 culverts located in the levee dividing the detention pool from the detention area. Water would flow from the detention area through 10 culverts to be constructed in L-31W, and it would flow southward toward Taylor Slough. Excess flood waters would be discharged through an emergency spillway on the south side of the pool. This would address that project objective of providing a more natural location of water deliveries by spreading flows across a broad front. The stormwater detention area would also provide some incidental water quality benefits by passing water deliveries through a shallow wetlands prior to discharge into ENP.

In the lower canal area, C-111 downstream of S-18C to S-197 would be backfilled with spoil material located on the southwestern canal bank. Water would be pumped from C-111E through a 500 cfs pump station, S-332B, via the Spreader Canal, across C-109 and C-110, through a 100 cfs culvert under U.S. Highway 1, and into the triangle between U.S. 1 and Card Sound Road. C-109 and C-110 would be plugged as described under the previous alternatives.

The features in the lower C-111 segment would address the objective of eliminating S-197 discharges. They would also restore natural hydrologic conditions and water flows in the SFWMD wetlands east of C-111.

5.6.4.6 Alternative 4

The objective of alternative 4 is to deliver more water to and create longer hydroperiods in the area north of Taylor Slough and the adjacent Rocky Glades west of L-31N. To provide for higher stages and longer hydroperiods in the marshes, a buffer zone would be created for protection of the developed areas east of L-31N. The buffer zone would extend from the 8.5-Square-Mile-Area through the Frog Pond to its south end. All of the Frog Pond and land in the newly created buffer zone would be required for this alternative.

A plan view is shown as alternative 4 in Figure 5-18. A new levee system with four pump stations (S-332A, S-332B, S-332C, and S-332D) would be constructed roughly parallel to L-31N and C-111, creating a buffer zone. At the south end of the buffer zone the new levee would turn eastward and tie to the C-111 levee. The cut off portion of L-31W to the west of the levee, and the part of L-31W south of the new levee would be filled to ground level.

The north end of the new levee would tie to the south end of the seepage levee near S-357, a structure in the 8.5-Square-Mile Area that is authorized as part of the Modified Water Deliveries to Everglades National Park project. For this alternative, S-357 is modified for 300 cfs capacity. The remainder of S-357's 533 cfs capacity proposed without alternative 4, would be pumped southward from the 8.5-Square-Mile-Area via this alternative's pump station S-332A.

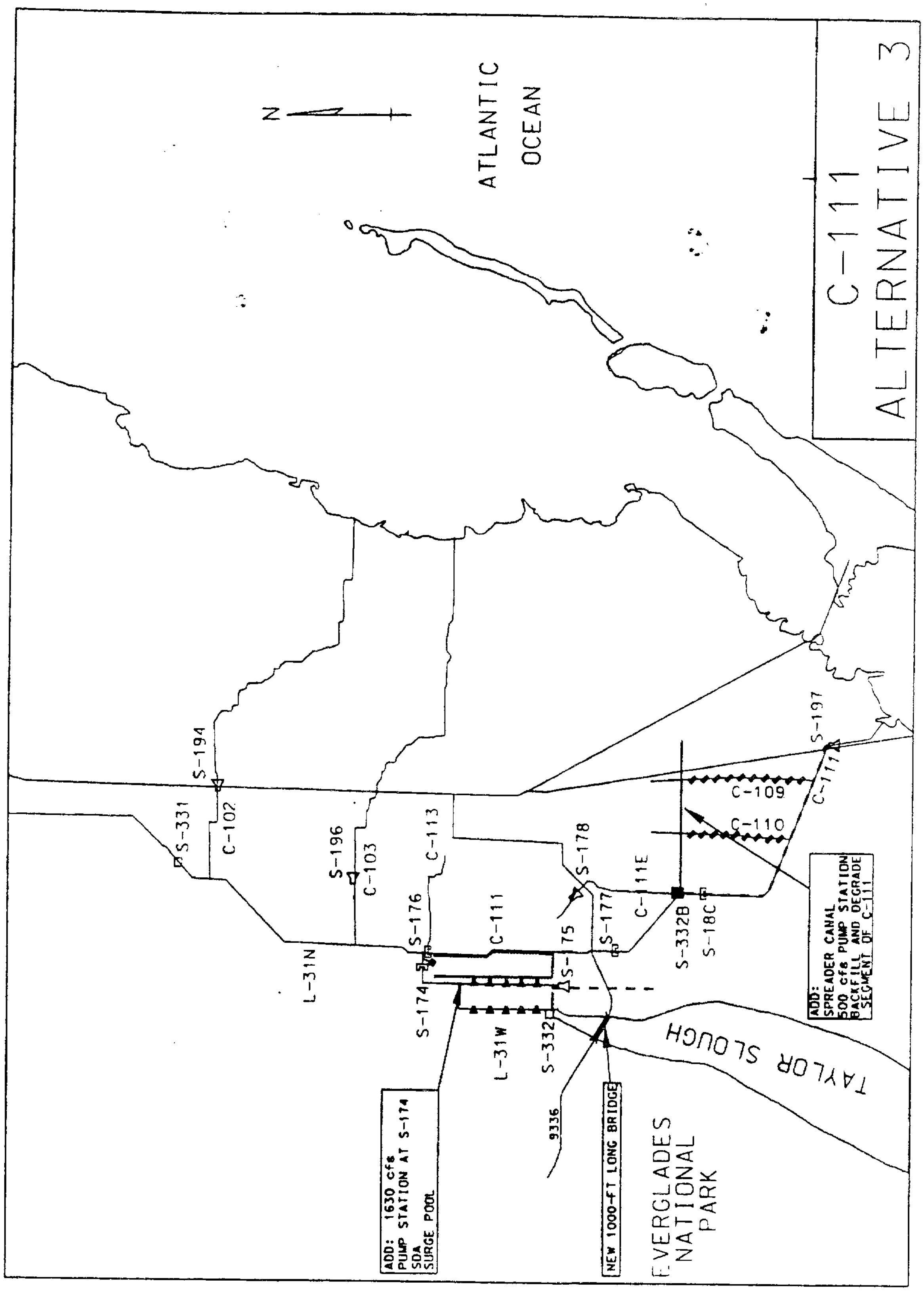

C-111
ALTERNATIVE 3
N
ATLANTIC
OCEAN
S-194
S-331
C-102
S-196
C-103
C-113
S-176
C-111
L-31N
S-174
L-31W
S-332
S-175
S-177
S-178
C-111E
S-332B
S-18C
C-109
C-110
C-111
S-197
TAYLOR SLOUGH
9336
EVERGLADES
NATIONAL
PARK
ADD: 1630 cfs
PUMP STATION AT S-174
SDA
SURGE POOL
NEW 1000-FT LONG BRIDGE
ADD:
SPREADER CANAL
500 cfs PUMP STATION
BACKFILL AND DEGRADE
SEGMENT OF C-111

FIGURE 5-17

Pump station S-332A would be located at the end of the seepage levee at the juncture with the new, alternative 6 levee. This and the three other pump stations would have four 75-cfs pumps. Each of the 300-cfs capacity stations would have a discharge sump on the outlet side; the sump would be 300 feet wide by 50 feet long, and have a depth of 5 feet.

S-332B and S-332C would draw water through flap-gate controlled culverts at the eastern end of connector canals from canal L-31N. The connector canals would also receive water drained from the buffer area through culvert/risers on each side of the connector canals.

S-332D pump station would be placed in the L-31W borrow canal downstream (west) of S-174, and would pump water from the L-31W canal west of S-174. Pump station S-332 would remain in service and be connected to C-111 via a new east-west connector canal. A flap-gate controlled culvert would divert water from C-111 to the connector canal. The connector canal would receive water from the buffer area via culvert/risers.

The pumps, canals, and levees forming the buffer strip features would address the project objective of restoring more natural location of water deliveries into the headwaters and upper portions of Taylor Slough. They would also address the objective of maintaining flood control capacity.

In the southern canal area, C-111 would be backfilled from its junction with C-111E to S-197. The Spreader Canal would be served by a 500 cfs pump station, S-332E, at the end of C-111E. The Spreader Canal would pass under U.S. Highway and provide up to 100 cfs to the triangle lands. Canals C-109 and C-110 would be plugged as described above to provide sheet flow from west to east along the alignment of the spreader canal. These features would address the project objective of restoring more natural flows and water conditions in the SFWMD wetlands east of C-111. Additionally, they would address the objective of reducing S-197 flood discharges to Manatee Bay/Barnes Sound.

5.6.4.7 Alternative 5

This alternative, as shown in Figure 5-19, requires fewer structures but requires purchase of the Frog Pond west of C-111 and east of L-31W. The lower end of L-31W would be filled, and structures S-332 and S-175 would be abandoned. A new 1,000 cfs pump station at S-174, designated S-332A, would push water from upper L-31W into the middle portion of Taylor Slough. This would be facilitated by degrading to adjacent grade any material along the west bank of the canal, including the tie-back levee from pump station S-332.

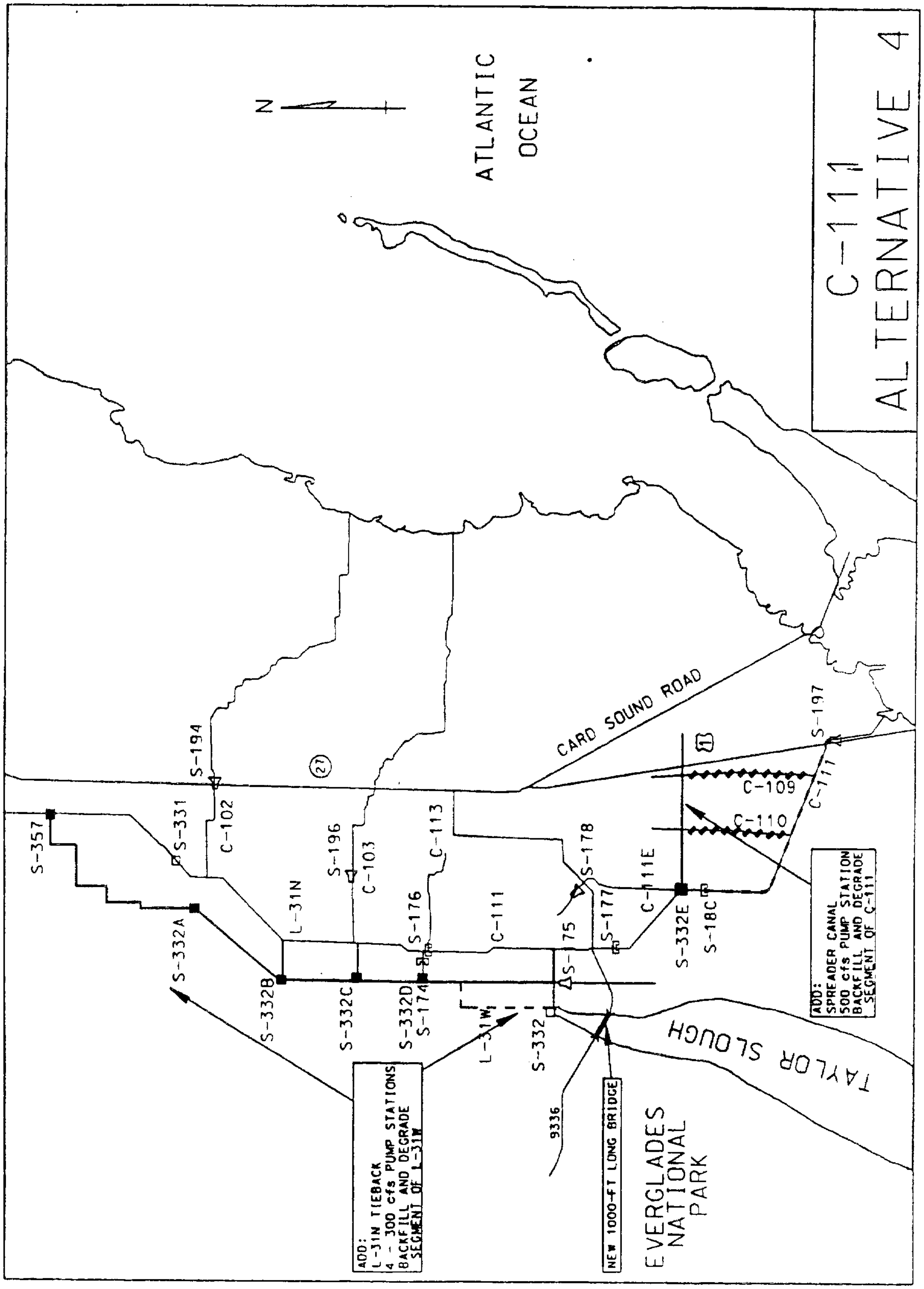

C-111
ALTERNATIVE 4
ATLANTIC
OCEAN
N
CARD SOUND ROAD
S-194
C-102
S-331
S-357
S-332A
S-332B
L-31N
S-196
C-103
S-332C
S-176
C-113
S-332D
S-174
C-111
S-175
L-31W
S-332
S-178
S-177
C-111E
S-332E
S-18C
C-110
C-109
S-197
C-111
TAYLOR SLOUGH
9336
EVERGLADES
NATIONAL
PARK
ADD:
L-31N TIEBACK
4 - 300 cfs PUMP STATIONS
BACKFILL AND DEGRADE
SEGMENT OF L-31W
NEW 1000-FT LONG BRIDGE
ADD:
SPREADER CANAL
500 cfs PUMP STATION
BACKFILL AND DEGRADE
SEGMENT OF C-111

FIGURE 5-18

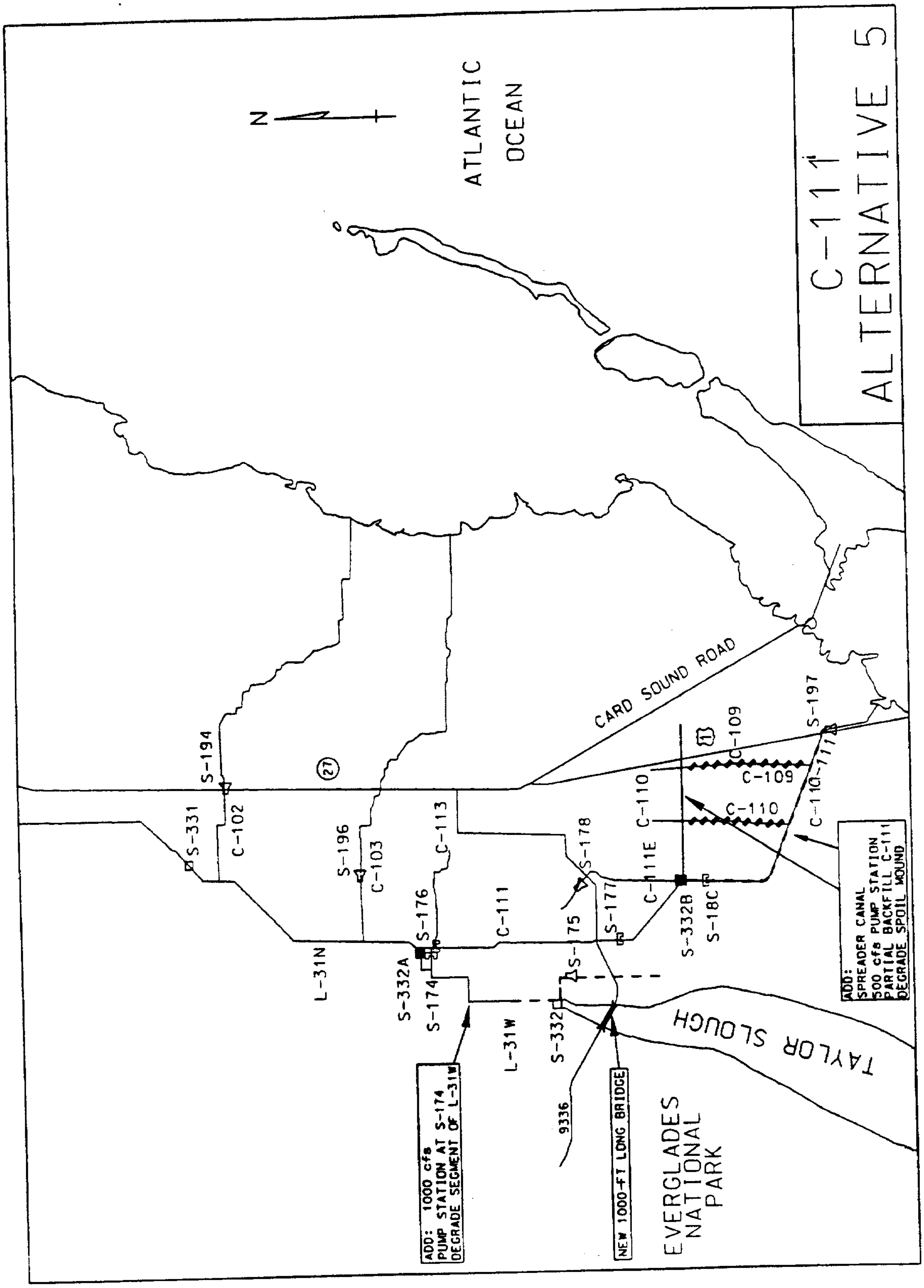

C-111
ALTERNATIVE 5
ATLANTIC
OCEAN
N
CARD SOUND ROAD
27
S-194
S-331
C-102
S-196
C-103
C-113
S-176
C-111
S-178
S-177
S-175
S-332A
S-174
L-31N
L-31W
S-332
S-332B
S-18C
C-111E
C-110
C-109
S-197
C-110-111
TAYLOR SLOUGH
9336
EVERGLADES
NATIONAL
PARK
ADD: 1000 cfs
PUMP STATION AT S-174
DEGRADE SEGMENT OF L-31W
NEW 1000-FT LONG BRIDGE
ADD:
SPREADER CANAL
500 cfs PUMP STATION
PARTIAL BACKFILL C-111
DEGRADE SPOIL MOUND

FIGURE 5-19

S-332A and the L-31W canal modifications would be intended to answer the project objective of restoring more natural flows across a broad area into the middle portion of Taylor Slough. This plan would have the additional benefit of minimizing additional physical disruption of existing wetlands caused by construction of new water management facilities. Additionally, these features would address the project objective of maintaining flood control capacity.

In the southern canal area, C-111 would be partially backfilled to -6.0 feet from C-111E to S-197. Fill would be taken from both banks. On the southeastern bank, the spoil would be removed so as to widen the existing gaps. On the northeastern bank, gaps would be created in the spoil adjacent to the existing culverts. The width of the gaps would be selected by balancing cut and fill requirements. These features would respond to the project objective of providing more natural water conditions through SFWMD wetlands east of C-111. They would also reduce the physical capacity to discharge flood waters to Manatee Bay/Barnes Sound.

Operation capability of S-18C would be retained by not filling the canal within 300 feet on the upstream or downstream sides. From these points fill would be placed on a 1 on 10 bed slope up to the fill elevation of -6.0 feet.

As in alternative 4, the Spreader Canal would be served by a 500 cfs pump, S-332B, providing 100 cfs to the triangle lands. C-109 and C-110 would be plugged as described in alternative 4 to provide sheet flow from west to east along the alignment of the spreader canal. The Spreader Canal and S-332B would serve two of the project objectives, reducing S-197 flood water discharges to Manatee Bay/Barnes Sound by providing alternative discharge capacity and restoring more natural flows through the SFWMD wetlands east of C-111.

5.6.4.8 Alternative 6

This plan combines the flexibility of alternative 4 in the upper area of Taylor Slough, coupled to the flexibility of alternative 1 in the lower C-111 basin as seen in Figure 5-20.

In common with alternative 4 is the objective to deliver more water to and create longer hydroperiods in the area north of Taylor Slough and the adjacent Rocky Glades west of L-31N. To provide for higher stages and longer hydroperiods in the marshes, a buffer zone would be created for protection of the developed areas east of L-31N. The buffer zone would extend from the 8.5-Square-Mile-Area through the Frog Pond to its south end. All of the Frog Pond and land in the newly created buffer zone would be required for this alternative.

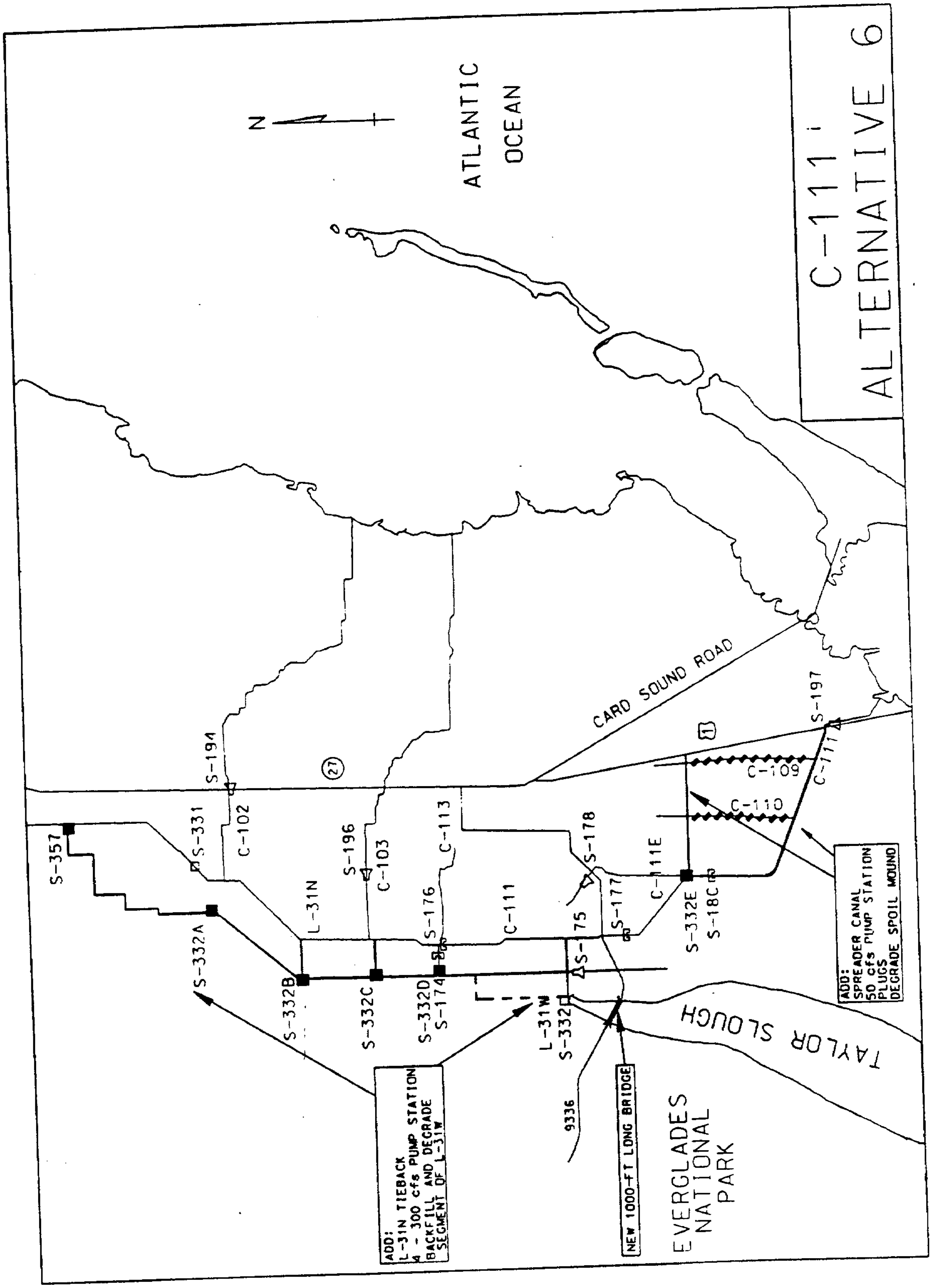

C-111
ALTERNATIVE 6
ATLANTIC
OCEAN
N
CARD SOUND ROAD
S-194
C-102
S-331
S-357
S-332A
S-332B
L-31N
S-196
C-103
S-332C
S-332D
S-174
S-176
C-113
C-111
S-175
S-178
S-177
C-111E
S-332E
S-18C
C-110
C-109
S-197
C-111
L-31W
S-332
9336
TAYLOR SLOUGH
EVERGLADES
NATIONAL
PARK
ADD:
L-31N TIEBACK
4 - 300 cfs PUMP STATION
BACKFILL AND DEGRADE
SEGMENT OF L-31W
NEW 1000-FT LONG BRIDGE
ADD:
SPREADER CANAL
50 cfs PUMP STATION
PLUGS
DEGRADE SPOIL MOUND

FIGURE 5-20

A new levee system with four pump stations (S-332A, S-332B, S-332C, and S-332D) would be constructed roughly parallel to L-31N and C-111, creating a buffer zone. At the south end of the buffer zone the new levee would turn eastward and tie to the C-111 levee. The cut off portion of L-31W to the west of the levee, and the part of L-31W south of the new levee would be filled to ground level.

The north end of the new levee would tie to the south end of the seepage levee near S-357, a structure in the 8.5-Square-Mile Area that is authorized as part of the Modified Water Deliveries to Everglades National Park project. For this alternative, S-357 is modified for 300 cfs capacity. The remainder of S-357's 533 cfs capacity proposed without alternative 6, would be pumped southward from the 8.5-Square-Mile-Area via this alternative's pump station S-332A. These features would address the project objectives of restoring natural hydrologic conditions to the headwaters and upper portions of Taylor Slough. Pump station S-332A would be located at the end of the seepage levee at the juncture with the new, alternative 6 levee. This and the three other pump stations would have four 75-cfs pumps. Each of the 300-cfs capacity stations would have a discharge sump on the outlet side; the sump would be 300 feet wide by 50 feet long, and have a depth of 5 feet.

S-332B and S-332C would draw water through flap-gate controlled culverts at the eastern end of connector canals from canal L-31N. The connector canals would also receive water drained from the buffer area through culvert/risers on each side of the connector canals.

S-332D pump station would be placed in the L-31W borrow canal downstream (west) of S-174, and would pump water from the L-31W canal west of S-174. Pump station S-332 would remain in service and be connected to C-111 via a new east-west connector canal. A flap-gate controlled culvert would divert water from C-111 to the connector canal. The connector canal would receive water from the buffer area via culvert/risers. By constructing four pump stations, water deliveries can be spread relatively uniformly across the entire border of the upper and middle portions of Taylor Slough.

The major difference in this alternative and alternative 4 is lower end of C-111. The flexibility to utilize lower C-111 for flood control discharges would be retained with alternative 6. Most flood control discharges would be made with S-197 closed. Flows would spill over the southern bank of C-111 and would pass through overland sheetflow across the park's panhandle area into northeast Florida Bay. Although the need to utilize S-197 would be greatly reduced with this alternative (because alternative discharge capacity is provided at S-332A, B, C, and D), there may still be a need to utilize the structure under extreme circumstances.

Identical to the lower basin of alternative 1 are the spreader canal, a 50 cfs pump station (S-332E), plugs in C-109 and C-110, and degradation of the spoil mound south of C-111 which would provide overland flow into the Eastern panhandle of the park.

5.6.4.9 Alternative 8

Subsequent to release of the preliminary draft report, the staff at the Everglades National Park recommended a conceptual plan, alternative 8, which includes features similar to those in alternatives 3, 4, and 6. Alternative 8 is shown in Figure 5-21. The main goal of this plan is the restoration of the stages in the headwaters and upper portions of Taylor Slough. This was accomplished in alternative 8 by pumping from L-31N borrow canal into the buffer strip rather than directly into the Park to the west. Evaluation of alternatives 1 through 6 showed that maintaining higher water levels along the border of ENP in this area is critical.

This plan is fully described in Annex F. It includes creation of a large buffer strip along the ENP boundary from Tamiami Trail southward to, and including the Frog Pond. The buffer strip includes the 8.5-square-mile and a strip of land to the north that extends eastward beyond Krome Avenue. Water would be discharged from the water management system into the buffer strip and water levels would be allowed to fluctuate in accordance with seasonal and annual rainfall cycles.

The concept includes operation targets for stages in the headwaters of Taylor Slough that would be achieved by strategically releasing water from the buffer strip into Taylor Slough. The plan would address the project objectives regarding restoration of natural hydrologic conditions in Taylor Slough, including the headwaters and upper portions and maintaining flood protection.

The lower portion of C-111 would be backfilled and a spreader canal and pump station would be constructed to discharge water into the east/ west spreader canal lands. This would address the project objectives of restoring natural hydrologic conditions in this area and eliminating S-197 discharges to Manatee Bay/Barnes Sound.

The major difference between alternative 8 and alternatives 4 and 6 is that it enables maintaining higher water levels along the boundary of ENP. The other alternatives call for pumping excess water at four discrete locations directly into the park but the hydrologic boundary is still the L-31N borrow canal. Since the canal stages cannot be raised without adversely impacting privately owned agricultural lands to the east, the problem of groundwater drainage from Taylor Slough into the canal would still exist. As a result, much of the water pumped into the park would return to the canal through seepage. Alternative 8 would involve pumping into the buffer strip and allowing water levels to be raised, thereby reducing seepage losses from Taylor Slough.

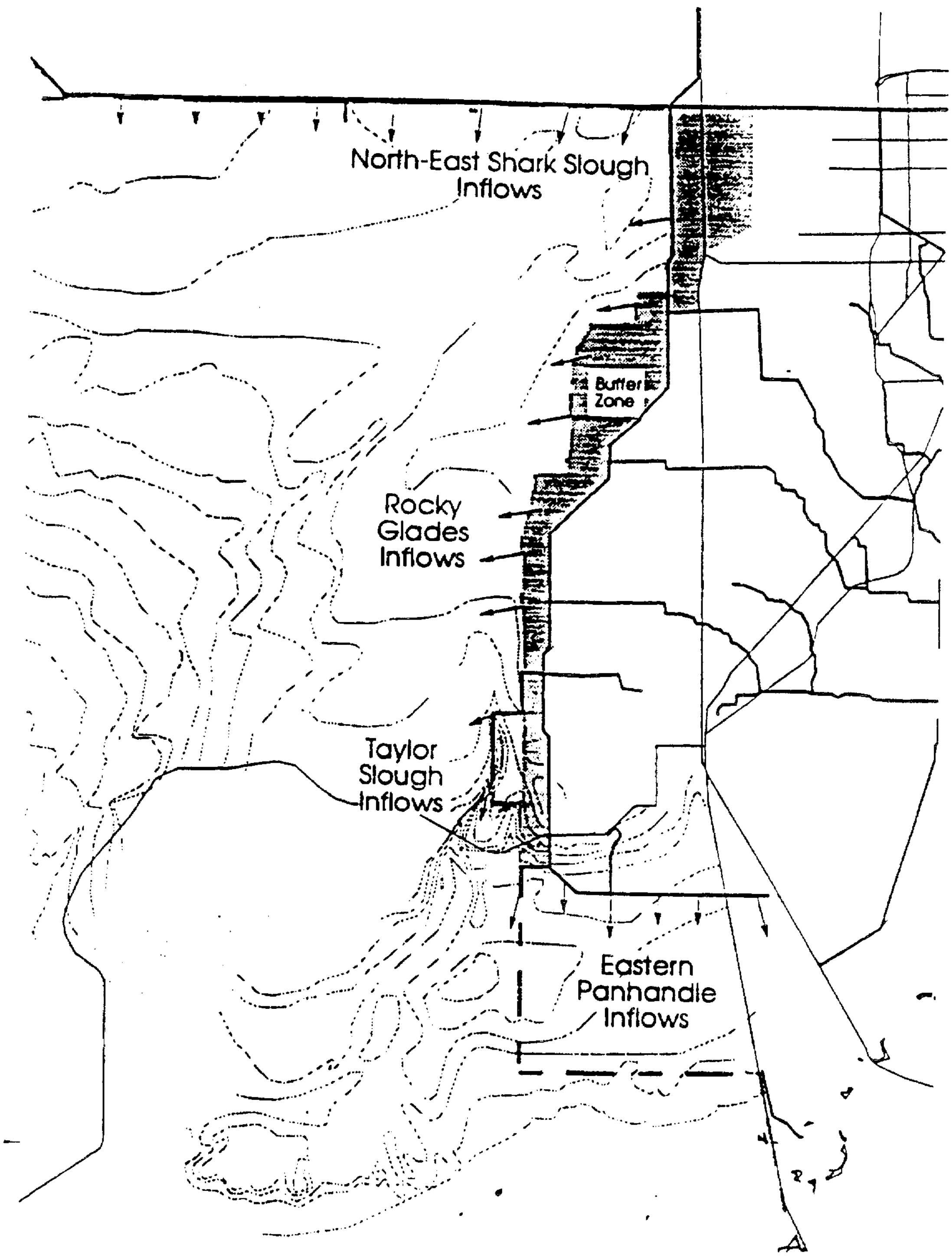


FIGURE 5-21 Proposed Alternative 8

Conceptually, alternative 8 offers distinct advantages over prior alternatives. However, as it is presented, alternative 8 includes features that are outside the scope of the C-111 project. Acquisition and utilization of lands in the 8.5-square-mile area and lands east of L-31N would not be within the available authority for the C-111 Project. Therefore, alternative 8 was refined so that it was within the scope of existing authority. Additionally, with input from ENP and SFWMD, engineering design refinements were also made. The new version of alternative 8 is alternative 6A.

5.6.4.10 Alternative 9

Another alternative was recommended by the South Dade Land Corporation and is shown as alternative 9 in Figure 5-22. This plan would surround the agricultural areas with a seepage curtain wall. The curtain wall extends the entire depth of the Biscayne aquifer, a depth of about 60 feet. All other features of the plan are identical to alternative 6 except that agricultural lands in the Rocky Glades agricultural area and the Frog Pond would not be acquired.

The purpose of this proposal was to create a seepage barrier between ENP and the farm land. The goal would be to enable higher water levels in Taylor Slough without impacting water levels in the adjacent agricultural areas. Seepage losses from ENP towards L-31N would be reduced considerably. As a result, project objectives of restoring natural hydrologic conditions in Taylor Slough and maintaining flood control would be addressed.

Several alternative designs for the curtain wall were developed, including metal and plastic sheetpile and a slurry trench. The most cost-effective method was a Gundwall plastic sheetpile with hydrotite, which costs approximately $6,623,000 per mile. Using a curtain wall alignment along the west boundary of the Frog Pond and extending northward along the western boundary of the Rocky Glades agricultural area for 16.3 miles, the cost of the installed sheetpile wall was approximately $108,000,000. The cost of purchasing these lands is $50,690,000. Other methods of installation are continuing to be evaluated, however, due to the high cost of installing the curtain wall in limestone, this alternative is still too costly for consideration.

The Corps has continued to assess the curtain wall technology. A 2-dimensional finite element program was used to calculate the depth of the curtain wall (See Appendix C). It was determined that the impermeable cutoff must extend the full depth of the aquifer to be effective. If the cutoff partially penetrates the aquifer, additional pump stations would be required to handle the resulting backseepage. This additional cost would make a partially penetrating cutoff much more expensive than a fully penetrating one. While this technology appears to be engineeringly feasible, the most difficult and potentially expensive portion of this work is the excavation of a trench through the limestone to the base of the aquifer. Although the technology currently exists to excavate the rock to the depths required for placement of the cutoff, the cost of this type of equipment is extremely variable. Estimates from various contractors involved with this type of work range from $15 to $20 per square foot of wall placed. However, all of the contractors contacted during this investigation have stated that trenches have not been excavated to the depths required by this project in rock materials.

5.6.4.11 Alternative 6A

A modification was performed to alternative 6 to bring in the major features of alternative 8, except backfilling the lower portion of C-111. Alternative 6A is shown on Figure 5-23. Alternative 8 was modified to include a sub-divided buffer strip. A central north/south levee is added to create a detention/retention zone in the west half of the area and a transition zone in the east half.

The detention/retention zone would be utilized for temporary storage of excess flood water before discharge into Taylor Slough. S-332A, B, C, and D would be pump stations designed to pump water across the transition zone via lined canals into the detention/retention zone. A battery of culverts and an overflow spillway would be constructed along the western levee of the detention/retention strip. Project objectives of restoring natural timing, location, and volumes of water flows to the headwaters, upper, and middle portions of Taylor Slough can be addressed by these features. Additional capacity at S-332A, B, C, and D could address the project objective of maintaining flood control capacity.

The transition zone would lie between the agriculture communities to the east and the detention/ retention zone to the west. This area would reduce the slope of the groundwater gradient from high water conditions in Taylor Slough and the L-31N borrow canal stage, thereby reducing seepage losses out of the wetlands.

Pump station S-332A, S-332B and S-332C would be located adjacent to L-31N levee. Each pump station would have four 75-cfs pump units. A concrete lined canal will be connected to the outlet side and discharge 1/2 mile west beyond the new L-31W tieback levee.

S-332D pump station would be placed in the L-31W borrow canal, west of S-174, and would pump water through a concrete lined canal connected to the outlet side of S-332D and discharge 0.5 mile west through the new S-332D Tieback levee into the new retention/detention zone. Pump station S-332 would remain in service and be connected to C-111 via a new east-west connector canal. A flap-gate controlled culvert would divert water from C-111 to the connector canal. The connector canal would convey runoff from the detention/retention area via culvert/risers.

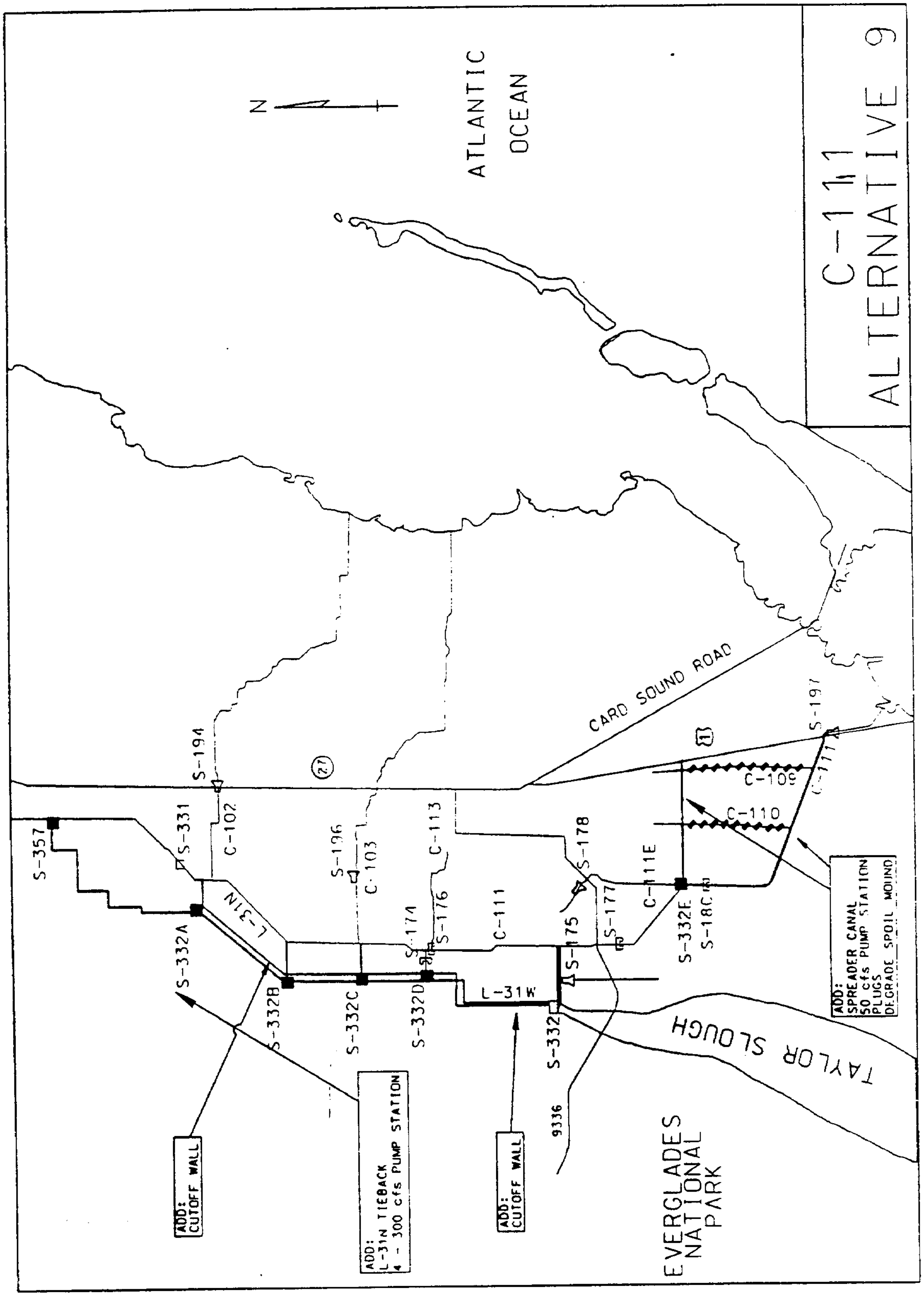
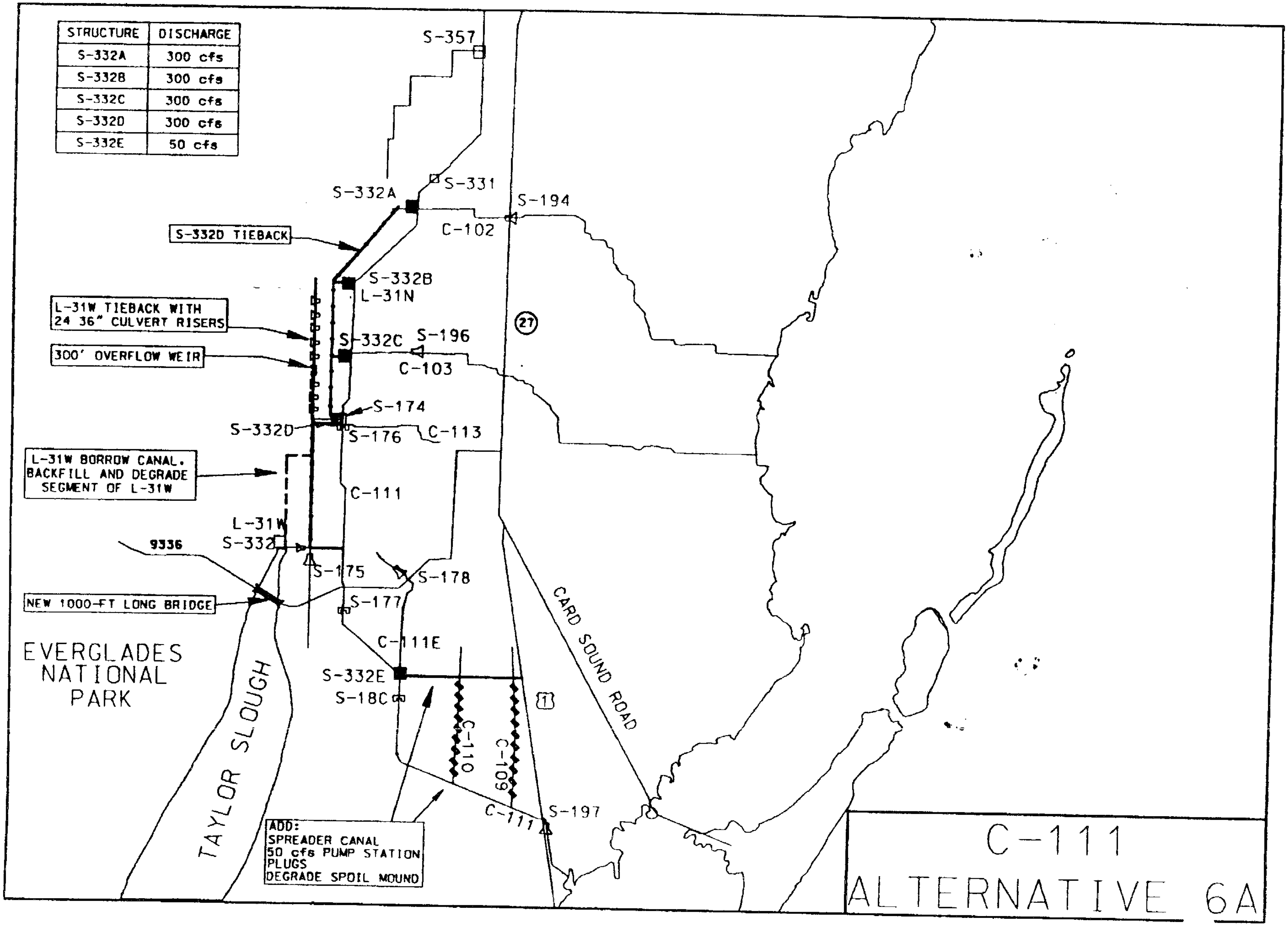

C-111
ALTERNATIVE 9
ATLANTIC
OCEAN
N
CARD SOUND ROAD
TAYLOR SLOUGH
EVERGLADES
NATIONAL
PARK
ADD:
CUTOFF WALL
ADD:
L-31N TIEBACK
4 - 300 cfs PUMP STATION
ADD:
CUTOFF WALL
ADD:
SPREADER CANAL
50 cfs PUMP STATION
PLUGS
DEGRADE SPOIL MOUND
S-357
S-331
S-332A
S-332B
S-332C
S-332D
S-332
S-332E
S-194
S-196
S-174
S-176
S-175
S-177
S-178
S-197
C-102
C-103
C-113
C-111
C-111E
C-110
C-109
L-31N
L-31W
9336

FIGURE 5-22



STRUCTURE	DISCHARGE
S-332A	300 cfs
S-332B	300 cfs
S-332C	300 cfs
S-332D	300 cfs
S-332E	50 cfs

FIGURE 5-23

Identical to the lower basin of alternative 6 are the spreader canal, a 50 cfs pump station (S-332E), plugs in C-109 and C-110, and degradation of the spoil mound south of C-111 which would provide overland flow into the Eastern panhandle of the park.

5.7 SECTION 122 EFFECTS

Effects of the alternatives on air, noise and water pollution, natural resources, and other types of resources listed in Section 122 of the 1970 River and Harbors and Flood Control Act are displayed in Table 5-2.

5.8 PRINCIPLES AND GUIDELINES EFFECTS

Effects of the alternatives on endangered and threatened species, historic and cultural properties, and other types of resources listed in the P&G are displayed in Table 5-3.

5.9 EVALUATION ACCOUNTS

Table 5-4 displays effects of the alternatives in the four evaluation accounts listed in the P&G - national economic development, environmental quality, regional economic development, and other social effects.

Table 5-2
Effects Evaluation:
Categories of Effects Listed in "Section 122"*

CATEGORIES OF EFFECTS	HISTORIC CONDITION	EXISTING CONDITION	"WITHOUT PROJECT" CONDITION (NO ACTION)	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 1A	ALT 8	ALT 9	ALT 6A
Air Pollution	L	L	L	0	0	0	0	0	0	0	N/A	0	0
Noise Pollution	L	L-M	L-M	0	0	0	0	0	0	0	N/A	0	0
Water Pollution	L	M**	M**	0	0	+	+	0	+	0	N/A	+	+
Man-made Resources	L	M	M	0	-	-	–	-	–	0	N/A	0	–
Natural Resources	H	M	L	+	+	+	+	+	+	+	N/A	+	+
Aesthetic Values	H	M	L	+	+	+	+	+	+	+	N/A	+	+
Community Cohesion	L	M	M	0	-	-	-	-	-	0	N/A	0	-
Public Facilities and Services	L	M	M	0	0	0	0	0	0	0	N/A	0	0
Employment	L	M	M	0	-	–	–	–	–	0	N/A	0	–
Tax Values	L	M	M	0	+	+	+	+	+	0	N/A	0	+
Property Values	L	M	M	0	+	+	+	+	+	0	N/A	0	+
Displacement of People	N/A	N/A	N/A	0	-	-	–	-	–	0	N/A	0	–
Displacement of Businesses	N/A	N/A	N/A	0	-	-	-	-	-	0	N/A	0	-
Displacement of Farms	N/A	N/A	N/A	0	-	–	–	–	–	0	N/A	0	-
Desirable Community Growth	N/A	N/A	N/A	0	0	0	0	0	0	0	N/A	0	0
Desirable Regional Growth	N/A	N/A	N/A	0	0	0	0	0	0	0	N/A	0	0

*"Section 122" is included in the River and Harbor Act of 1970.
** Phosphorus routinely measured at S-332

Historic, existing and "without project" conditions display estimates of each resources relative values : H = high, M = moderate, L = low.
Plans' effects are estimates of net overall changes from the "without project" condition:

+ = beneficial change
0 = no change
- = adverse change
– = very adverse change
N/A = not applicable

Alternative 8 was outside scope.

Table 5-3
Effects Evaluation:
Categories of Natural and Cultural Resources Effects
Listed in the "Principles and Guidelines"

CATEGORIES OF EFFECTS	HISTORIC CONDITION	EXISTING CONDITION	"WITHOUT PROJECT" CONDITION (NO ACTION)	ALT 1	ALT 1A	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 8	ALT 9	ALT 6A
Air Quality	Good	Good	Good	No change	No change	No change	No change	No change	No change	No change	No change	No change	No change
Areas of particular concern within the coastal zone	None	None	None	*Minor change with introduction of fresh water.									
Endangered and threatened species	Not applicable	2 species	2 species	No effect pending the U.S. Fish and Wildlife Service concurrence. USFWS will provide an evaluation of the effects and this will be shown in the final document.									
Historic and cultural properties	Not applicable	Few known sites		Possible effects to unknown resources on tree islands.									
Prime and unique farmlands	Not applicable	No change	No change	No change	No change	Loss of 1800 acres (Western Frog Pond)	Loss of 5255 acres (Frog Pond)	Loss of Frog Pond and portion of Rocky Glades	Loss of 5255 acres (Frog Pond)	Loss of Frog Pond and portion of Rocky Glades			Loss of Frog Pond and portion of Rocky Glades
Water Quality	Good	"Fair" Potential Phosphorus problems	"Fair" Potential Phosphorus problems	"Fair" Potential Phosphorus problems	"Fair" Phosphorus problems	"Fair" Potential Phosphorus problems	"Fair - good" Potential Phosphorus problems. Could improve WQ.	"Fair" Potential Phosphorus problems	"Fair" Potential Phosphorus problems	"Fair" Potential Phosphorus problems	N/A	"Fair" Potential Phos. problems	"Fair - Good" Potential Phosphorus problems
Wild and scenic rivers	Not applicable	0 miles	0 miles	No change	No change	No change	No change	No change	No change	No change			No change

*1 Not accurate representation. Corps had authority to raise water levels to optimum levels prior to enactment of this Act. Unique farm land created from lowered canal stages and tropical climate.

N/A Alternative 8 was not evaluated due to its scope.

Table 5-4
Effects Evaluation:
Evaluation Accounts Listed in the "Principles and Guidelines"

EVALUATION ACCOUNTS	HISTORIC CONDITION	EXISTING CONDITION	"WITHOUT PROJECT" CONDITION (NO ACTION)	ALT 1	ALT 1A	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 8	ALT 9	ALT 6A
NATIONAL ECONOMIC DEVELOPMENT ACCOUNT													
Project Cost ($million)[1]	NA	NA	NA	$36.8	$26.5	$45.7	$74.8	$128.3	$62.1	$121.9	NC	$179.2	$121.4
Annual Benefits	NA	NA	NA	$3.2	$3.2	$3.0	$2.9	$2.9	$2.9	$2.9	NC	NC	$2.9
Annual Costs (8%)	NA	NA	NA	$4.1	$3.0	$4.8	$7.7	$12.9	$6.4	$12.2	NC	$14.2	$12.0
The flood control component of all plans is 1.05 to 1.0.													
ENVIRONMENTAL QUALITY ACCOUNT													
Ecological Value	high	low	low	min effect - low	min effect - low	min effect - mod.	improv. mod - high	improv. high	improv. mod to high	improv. high	NC	improv. high	improv. high
Cultural Value	high	high	high	Water levels or volumes may impact tree islands or oak hammocks which may be adversely affected and require compliance.									
Aesthetic Value	high	low	low	Construction will have some negative impacts for a short time.		Construction will have some negative impacts for a short time. Former agricultural lands will enhance the overall visual experience of visitors to the park.					NC	Same as alt 1	Same as alt 6

[1] May 1993 price levels
NA - not applicable
Flood Control - All plans provide approximately the same level of flood protection with no adverse impact to the environment. Alternative 1A, the flood control plan is implementable, but not acceptable to the sponsor. The construction features are the basis for flood control in all plans.
N/C - Not included

Table 5-4 (Continued)
Effects Evaluation:
Evaluation Accounts Listed in the "Principles and Guidelines"

EVALUATION ACCOUNTS	HISTORIC CONDITION	EXISTING CONDITION	"WITHOUT PROJECT" CONDITION (NO ACTION)	ALT 1	ALT 1A	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 8	ALT 9	ALT 6A
REGIONAL ECONOMIC DEVELOPMENT ACCOUNT													
Regional income	low	moderate	moderate	min. effect	minimum effect	mod. neg. effect	mod. neg. effect	Major neg. effect due to loss of ag. lands	mod. neg. effect	Major neg. effect due to loss of ag lands	NA	min effect	Major neg. effect due to loss of ag lands
Regional employment	low	moderate	moderate	min. effect	minimum effect	mod. neg. effect	mod neg. effect	mod - major neg. effect	mod. neg. effect	mod.- major neg. effect	NA	min effect	mod. - major neg., effect
OTHER SOCIAL EFFECTS ACCOUNT	NA	NA	NA	minimal land purchase	minimal land purchase	purchase west Frog Pond	purchase all Frog Pond	purchase all Frog Pond and Rocky Glades	purch. all Frog Pond	purch. all Frog Pond and Rocky Glades	NA	min. land purch.	purch. all Frog Pond and Rocky Glades

[1] May 1993 price levels
NA - not applicable

5.10 ENVIRONMENTAL EVALUATION OF ALTERNATIVES

Environmental impacts of alternatives were evaluated on two levels:

1) evaluation of the alternative's potential for meeting the planning objectives described in section 5.2.

2) assessment of the direct effects of construction of the recommended plan on the important environmental resources in the area.

The latter required an enumeration and comparison of the quantities of aquatic and wetland habitats that would be changed. The results of this evaluation are presented in Table 5-5. Because alternative 9 is not cost effective, environmental benefits were not computed. The difference between alternative 6 and 6A are minor. The physical differences are within the 1-square-mile grid size used for the hydrologic model used for the evaluation. Therefore, the outputs for both alternatives are the same.

Alternatives' potential for restoring historic hydrological conditions and protecting or restoring natural values associated with ENP were evaluated by comparing modern historic conditions with projected alternative conditions. Modern historic conditions are those under which marl soil was formed and is maintained in the study area. They include the geological, hydrological and biological processes summarized in Section 2.4.

The comparison of projected alternative conditions with the historic hydrological determinants that produced Everglades habitat and natural values required consideration of (a) the expanse of area that would get more or less water in appropriate time frames, and (b) the degree of restoration of the historic hydrology in which the marl soil habitat was formed and maintained (Section 2.5).

A marl model (hydrohabitat model) incorporating these two considerations was developed. Independently of the marl model, a species compatibility index was used to gauge the restoration of projected natural habitat values under the alternatives.

♦ Use of the marl model involved calculations of a hydrohabitat index (HhI) for each alternative. The HhI is an evaluation of the habitat value of projected water levels and durations in square-mile cells. The HhI was combined with the total area of hydroperiod change to produce a hydrohabitat unit (HhU) value for each alternative. The HhU value is a measure of how well an alternative's hydrology supports the natural values associated with the sawgrass-on-marl ecosystem.

♦ Species compatibility indices are founded on species habitat requirements in the natural, fresh water ecosystem of ENP. Hydrological criteria defined by the ENP staff as favorable to selected indicator species were incorporated with the output of

Table 5-5
Summary of Environmental Impacts from Construction of the Recommended Plan

Features	Wetlands:Loss (Gain)		Agriculture Lands: Loss (Gain)	
	Dredge (acres)	Fill (acres)	Dredge (acres)	Fill (acres)
Pump Sta (S-332 A, B, C) Discharge Canals	-	-	15	-
Connecting Canal C-111 to S-332/S-175	-	-	11	-
S-332D Tieback	-	7	-	383
L-31N Tieback				
N. of S-332D	-	7	-	9
S. of L-31W	-	-	-	15
Spreader Canal	61	-	-	-
L-31W	-	15	-	-
C-111 spoil removal	(61)	-	-	-
Net Quantities	0	29	26	407
Ag Land Made Fallow	-	-	-	9000
Totals	29		9,433	

hydrological modeling of alternatives, using the authorized optimum water stages within the C-111 system. The resulting values represent the extent to which an alternative protects or restores the selected species's habitat requirements for reproductive success.

The methods are discussed in following paragraphs and in Annex G. The evaluations of finally considered alternatives are presented in section 5.14 and in tables 5-6 and 5-7.

5.10.1 Marl Soil Ecosystem Criteria

The environmental effects of each alternative plan were evaluated based, in part, on the similarity of projected hydrological conditions to historic conditions deduced from marl measurements (Annex G). For this portion of the evaluation, the study area was considered as 2 basins: the east basin, south of the spreader canal between a line extended south from C-111E and Card Sound Road, and the remaining west basin (Figure 5-24).

The following characteristics of the marl soil area of the East Everglades (TBI, 1990) were used to construct a marl model for rating projected alternative water levels against reported historic conditions:

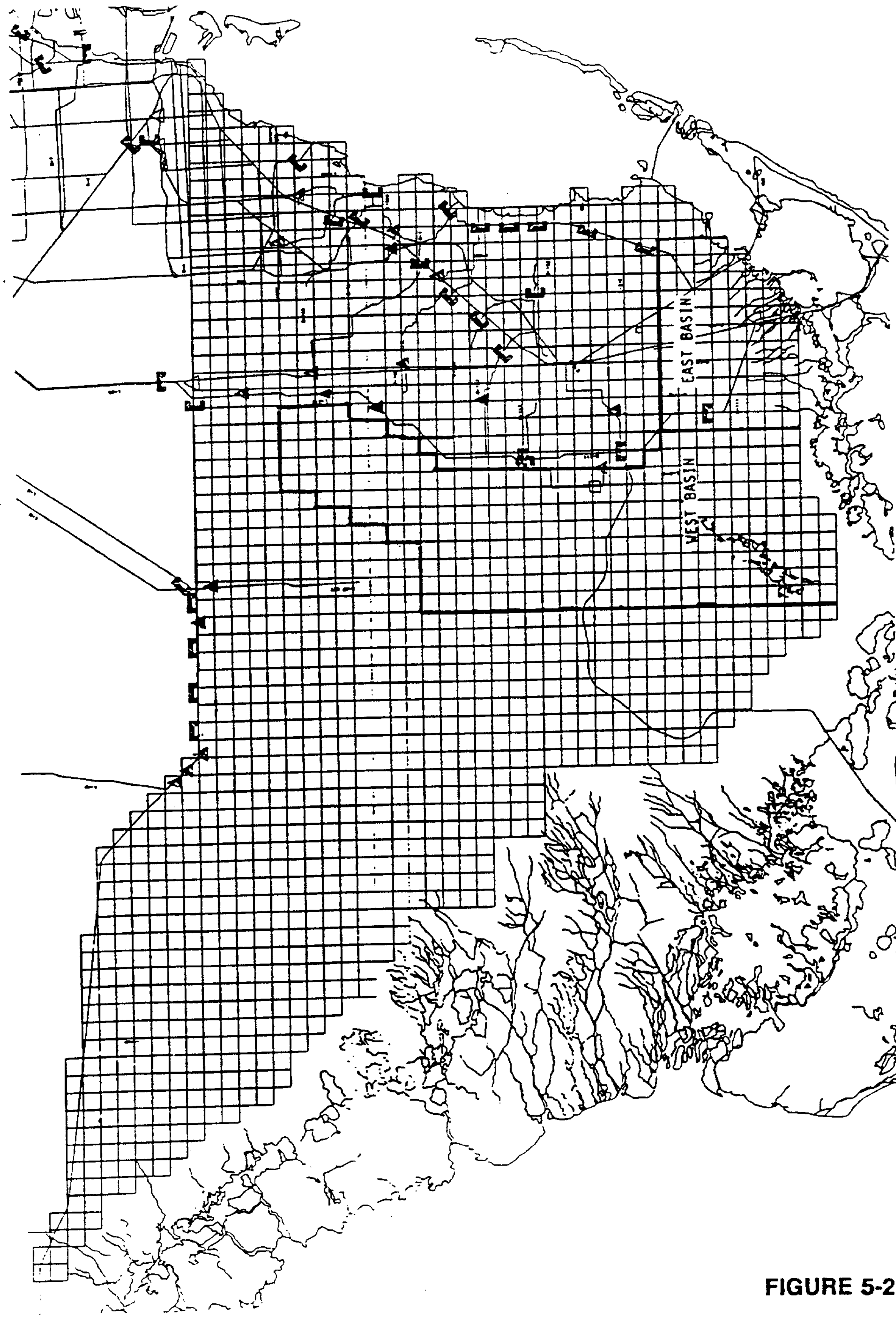
- Marl soils were formed and maintained under an average hydroperiod of about 7 months.

- Water levels may have reached lows of 20-30 inches below ground level. Water recession of from 24 inches to 30 inches below ground level might cause rapid and complete loss of water from marl soils and death of hydric, vascular plants.

- The average depth of flooding was 8.5 inches over marl soil and ranged from 3.2 inches to 20.9 inches.

The marl model (Annex G) was used to objectively assign a value between zero (0.00) and one (1.00) to projected water regimes under each alternative plan. The values, termed hydrohabitat indices (HhI), were derived as follows.

Using the marl model, alternative plans were rated for the west basin and for the east (lower C-111) basin by calculating an intermediate hydrohabitat index (HhI) value for each of 3 inundation conditions modeled on the period of record: wet (10 percent exceedance), dry (90 percent exceedance), and average (50 percent exceedance). These values were combined to produce an HhI for each basin under each alternative (the cube-root of the product of the three values).



C-111: East Basin and Maximum West Basin Areas

FIGURE 5-24

The marl model was capable of providing the maximum hydrohabitat index (HhI) value of 1.0 for water depths and conditions as follows:

- Depths no less than 0 inches (ground level) would be exceeded 90 percent of the time, and

- Depths no less than 8.5 inches would be exceeded 50 percent of the time, and

- Depths up to 21 inches may be reached 10 percent of the time.

A zero HhI value would result from a water level of -30 inches (below ground). Higher water levels that are less than optimum in a basin (east or west) cause alternatives to receive HhI values between 0.99 and 0.10.

The product of a basin's HhI and its affected area (square miles) is that basin's hydrohabitat unit (HhU) value. The sum of an alternative's east and west basin HhU values is the alternative's HhU.

The affected area of each basin is different under each alternative. The affected area for the base condition is the total area with a hydroperiod of 6 months or more: 687 square miles in the west basin and 71 in the east basin. (Table 9, Annex F, shows, for an average year, 758 square miles of the study area with a hydroperiod of 6 months or more. A count of square-mile units in the east basin showing a 6-month or greater hydroperiod--using a 5-color version of Plate 9, Annex F--yields the above-mentioned 71 square miles in the east basin, leaving 687 square miles in the west basin). The affected area for each alternative was determined similarly.

The total, potentially affected area, 1,557 square miles (1,471 sq. mi. west basin and 86 sq. mi. east), represents the maximum conceptual HhU. This is for average conditions over the historic period--greater than the period of rainfall record.

The HhU value is regarded as a gauge of how well an alternative's hydrology supports the sawgrass-on-marl ecosystem, compared to the base and other alternative conditions. Table 5-6 contains a comparison of HhU values for each basin under each alternative.

Alternatives 6 and 6A show over 100 percent improvement in hydrohabitat quality over the base condition. The alternative showing the next most improvement, alternative 4, improves habitat quality over base condition by 97 percent. Alternatives 6 and 6A have the potential for delivering water high in the rocky glades, into Taylor Slough, and south of lower C-111 in quantities and with the timing that contribute to 100 percent-improved habitat quality. These alternatives maintain dry season, sub-surface water at higher elevations in both east and west basins and increase water supply to the north part of the west basin.

Table 5-6
C-111
Hydrohabitat Indices, Area and Hydrohabitat Units For
Restored, Existing and Alternative Conditions

	MAXIMUM CONCEPTUAL SCORE	EXISTING CONDITION	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
HYDROHABITAT INDICES								
WEST BASIN	1.0	0.19	0.27	0.15	0.25	0.26	0.26	0.27
EAST BASIN	1.0	0.39	0.44	0.46	0.43	0.39	0.411	0.43
SQUARE MILES								
WEST BASIN	1471	687	829	829	917	1034	938	1027
EAST BASIN	86	71	118	130	127	116	123	128
HYDROHABITAT UNITS (HhU)								
WEST BASIN	1486	131	242	124	229	269	244	273
EAST BASIN	71	28	52	60	55	45	50	55
TOTAL HhU	1557	159	294	184	284	314	294	332

As measured, using the design water management schedule, all alternatives produce drier than optimum marl habitat conditions. In the dry season, water levels drop at least 12 inches below the ground surface, where water is held in solution cavities, in water control-structure receiving basins, and, perhaps, in alligator holes.

5.10.2 Species Compatibility Index

Eight species and biological communities were selected jointly by ENP, the USFWS, the Florida Game and Fresh Water Fish Commission, and the US Army Corps of Engineers as indicator species whose habitat requirements could be used to evaluate alternative plans. The species are the wood stork, roseate spoonbill, Cape Sable sparrow, and American alligator. Additionally, fresh water fish communities in Taylor Slough and in the marl prairie, the estuarine fish community and emergent plants were selected.

Optional hydrological criteria for the indicator species in the study area were defined by the ENP staff, as follows:

ENP data indicate that wood storks begin breeding colony formation earlier in years when extensive areas of higher-elevation, marl prairie are flooded in the early dry season (November-December). Based on the hypothesis that colonies that form earlier are more likely to be successful than those that form later, ideal conditions are defined as those that produce the greatest area of surface water flooding during November and December.

Data on the roseate spoonbill compiled by ENP suggest hydrological limitations that define best conditions for reproductive success. Colony success appears greatest when adult birds can find adequate feeding conditions in the mainland wetlands mostly east of US Highway 1 and in the lower portions of the C-111-Taylor Slough basin.

Ideal foraging conditions are created by extensive flooding early in the nesting season months of November and December, followed by moderate, regional drying patterns during the nestling season through March. Drying that is too slow does not adequately concentrate prey, and when it is too rapid, the adult birds must fly greater distances to find foraging sites. Ideal conditions would have the largest, lower basin land area flooded during November, and 50-75 percent of the area dry by the end of March. These conditions occur infrequently in the C-111 study area, which provides only the western extremity of the spoonbill's present foraging range.

Cape Sable sparrow data suggest that nesting is reduced when surface water is present in the colony sites during the February to June nesting season. The best condition has the smallest flooded area in the marl prairie habitats during the nesting months.

ENP data suggest that the number of adult female alligators that initiate nesting during June each year is proportional to the area of surface flooding in the sloughs during the courtship period in April and May. The ideal condition has the most land area flooded during April and May.

Emergent aquatic plants in the marl prairie-Taylor Slough area are reported to be stressed or killed when the water level recedes to greater than 24-30 inches below ground surface. Best habitat conditions are those with a minimum of area with subsurface drying greater than 30 inches for two or more consecutive months per year.

Criteria for fresh water fishes in Taylor Slough are specified as the largest spatial area with uninterrupted, year-to-year flooding. In the marl prairie area, ideal habitat conditions are (a) the maximum land area in the marl prairie where (b) water depths are less than 1 meter below ground (c) 12 months per year.

Estuarine fishes have habitat requirements that ideally provide (a) the largest land area in lower C-111 and Taylor Slough basins with (b) surface water depths greater than 0.5 feet (c) during the late wet season months of September-October.

The criteria were incorporated with the output of hydrological models of alternative plans under the schedule of optimum water levels prior to the interim test (base condition) to produce a compatibility index for each species under each alternative. An alternative's species compatibility index is the product of the time period in months and the number of square-mile cells that coincidentally meet the optimum habitat conditions for a species. The resulting numbers represent the areal extent and frequency with which an alternative meets a faunal species's or a plant community's hydrological requirements for optimal reproductive success. The output numbers are shown in Table 5-7. Because alternative 9 was not cost effective, a species compatibility score was not computed.

These groups have differing, in some cases competing, seasonal habitat requirements. The differences are magnified when ideal reproductive conditions for each group are compared. The competing requirements, perhaps, contribute to causing the Species Compatibility scores to show small differences between alternatives. Alternatives show notable improvements for one or two indicator groups, but poor potential for other groups. This is to be expected among competing groups.

Table 5-7
C-111
Species Compatibility Scores
For
Restored, Existing and Alternative Conditions

SPECIES OR COMMUNITIES	MAXIMUM CONCEPTUAL SCORE	EXISTING CONDITION	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6 and 6A
WOOD STORK	458	41	44	45	59	62	51	59
ROSEATE SPOONBILL	17	8	8	9	4	5	4	9
CAPE SABLE SPARROW	1145	350	354	356	409	348	349	361
AMERICAN ALLIGATOR	172	50	51	50	51	51	50	51
FRESH W. FISH TAYLOR SLOUGH	86	8	8	8	8	8	7	8
FRESH W. FISH MARL PRAIRIE	2748	2356	2360	2370	2370	2357	2386	2379
ESTUARINE FISH	344	211	219	224	240	232	223	228
EMERGENT AQUATIC PLANTS	172	71	72	76	77	74	76	74

An independent analysis was performed by ENP staff, using 5 of the species and communities. The ENP report of its analysis is included as Annex F. The ENP analysis and that of the Corps are similar.

5.10.2.1 Emergent Plant Criteria

Considering only the depth limit of low ground water tolerated by emergent plants in the study area and ignoring high water limitations and hydroperiod, alternative 3 is a 9 percent improvement over the existing condition. Other alternatives allow ground water to drop below 30 inches below ground level more often or in a larger area. Alternative 5 produces only 8 percent improvement over the existing condition, and other alternatives provide less improvement (Table 5-7).

5.10.2.2 Estuarine Fish Criteria

Surface water greater than 0.5 foot during the late wet season months, September and October, optimum for estuarine fishes, probably was a common historic occurrence in the lower C-111 and Taylor Slough basins (section 2.5). As modeled under the base condition, alternatives 3, 4, and 6/6A have the greatest tendency toward the criteria condition, improving the existing condition by amounts from 8 percent (alternatives 6/6A) to 14 percent (alternative 3). Alternative 1 contributes least toward benefiting estuarine fishes (4 percent improvement over the existing condition).

5.10.2.3 Fresh Water Fish, Marl Prairie Criteria

Conditions that favor fresh water fish in the marl prairie would have (a) the minimum land area in the marl prairie where (b) water depths are 1 meter or more below ground (c) for one or more months during the year. Alternatives except 1 and 4 provide marginal improvement over existing conditions. The other two alternatives provide less than 1 percent improvement, but under all alternatives water is present in subsurface refugia to at least 0.6 meter below ground level.

5.10.2.4 Fresh Water Fish, Taylor Slough Criteria

Uninterrupted surface flooding over an extended time period, i.e., consecutive years, is the condition that favors increasing density and biomass of fishes. Only a small area in Taylor Slough is capable of providing an area of such flooding. Alternatives 1 and 4 produce a 5 percent increase over existing condition, and alternative 6 produces a 3 percent increase in such an area. All other alternatives decrease the area of interannual flooding.

5.10.2.5 Wood Stork Criteria

ENP observations support the hypothesis that stork colonies in ENP form earlier in years when extensive areas of the higher elevation, marl prairie marshes are flooded in the early dry season (November-December), and form later in years when the prairies are dry during those months. Such conditions are improved under alternative 4 by 49 percent and under alternatives 3, and 6 by 43 percent over the existing condition. Alternative 5 represents a 42 percent improvement, and alternatives 1 and 2 provide 5 percent to 8 percent improvement, respectively.

5.10.2.6 Roseate Spoonbill Criteria

Spoonbills nest along the mainland coastal wetlands and rear the young from January through March. Ideal foraging conditions are created by extensive flooding early in the nesting season (November-December), followed by moderate, regional drying patterns through March. Ideal reproductive conditions are those with the greatest land area flooded in the lower basins during November, with 50-75 percent of the map-cells dry by the end of March (ENP). The alternatives with lower C-111 left unplugged, alternatives 6 and 2, provide a 12 percent improvement, modeled with the base condition. The others provide no improvement or worsen conditions compared to the existing condition.

5.10.2.7 Cape Sable Sparrow Criteria

With acceptance of data that suggest that Cape Sable sparrow nesting effort is reduced in colony sites when surface water is present during the February to June nesting season, alternatives 4 and 5 may be ranked as favorable. These alternatives cause the known colony sites to be surface dry in the nesting season and are an improvement over the existing condition. Under alternatives 6 and 6A, 0.1 feet of water may cover a portion of the southern nesting area in the early part of the nesting season, and deeper water (0.4 feet) may be present under the other alternatives.

5.10.2.8 Alligator Criteria

Conditions providing for surface flooding in the sloughs during the alligator courtship period in April and May favor alligator reproduction. None of the alternatives, as modeled under the base condition, improve upon existing conditions by more than 3 percent.

5.11 SALTWATER INTRUSION

The Biscayne Aquifer underlies approximately 3,000-square-miles of Dade, Broward, and southern Palm Beach Counties. It is a surficial, highly permeable, wedge shaped aquifer that is about 200 feet thick at the coast but thins to a few feet thick near its western boundary 35 to 40 miles inland. This aquifer, and surficial aquifers in Palm Beach County, provide water for municipal and industrial water supply, and agricultural irrigation along the southeast coast. Seepage and water supply releases from the WCA prevent saltwater intrusion along the coast and recharge the surficial aquifers. The original design of the ENP-South Dade County Conveyance Canal system considered that, except at coastal salinity structures, canal stages would be permitted to recede approximately 1.5 feet below the optimum levels before supplemental water was introduced into the ENP-South Dade County Conveyance Canal system. The alternative plans use this operating criteria, therefore, it is anticipated that there would be no change in salinity encroachment problems.

5.12 PLANNING CRITERIA

Performance of the alternatives with respect to planning criteria, including the planning objectives, planning constraints, evaluation factors and the four P&G criteria of completeness, effectiveness, efficiency, and acceptability, is displayed in Table 5-8.

5.13 PUBLIC VIEWS

There are a few general themes that persist throughout public sentiment with regard to the alternative plans. Among the environmental community, there is a need to restore the flow of water to Everglades National Park, through Taylor Slough and the Eastern panhandle of the Everglades. Surface waters flow southward from Taylor Slough before merging into Florida Bay via a number of small creeks and channels. Taylor Slough was historically a major contributor of freshwater to Florida Bay. The slough is also an important ecosystem in its own right, providing critical habitat for a variety of native Everglades flora and fauna.

Conversely, the agricultural community is concerned that project modifications for water delivery to the park will adversely impact agriculture production within the C-111 study area. Agricultural productivity requires lower canal stages during the planting season. If canal stages are too high, row crops cannot be planted early enough for the crops to be marketed within the optimum time frame. High canal stages can also damage the root zones of tree crops which can lead to loss of the crop and/or death of the tree.

5.14 EVALUATION OF ALTERNATIVE PLANS

The evaluation factors described in Section 5.5 were utilized to measure each alternative plan's effectiveness at satisfying the project objectives described in Section 5.2. Inasmuch as the C&SF Project impacts hydrologic conditions in Taylor Slough and Florida Bay, the principle objective of this project is the restoration of hydrologic conditions in the C-111 basin, including Taylor Slough. If this objective is accomplished, the project objective of protecting the natural resources of ENP will also be satisfied.

Table 5-8
Planning Criteria Evaluation

PLANNING CRITERIA	"WITHOUT PROJECT" CONDITION (NO ACTION)	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6 and 6A	ALT 1A
OBJECTIVES:								
Restoration of historic hydrologic conditions	0	+	+	+	+	+	+	+
Protection of natural values associated with ENP	0	+	+	+	+	+	+	+
Elimination of excess freshwater inflow to Manatee Bay/Barnes Sound	0	+	+	++	++	+	+	+
Maintain flood protection for agriculture	0	+	+	+	+	+	+	+
EVALUATION FACTORS:								
Operational Flexibility	0	+	+	+	+	+	++	+
Cost Effective	0	+	+	+	+	+	+	+
Environmental Outputs	0	+	+	++	++	+	++	+
Flood Control Impacts	0	+	+	+	+	+	+	+
P&G FOUR CRITERIA								
Completeness	Not applicable	High	High	High	High	High	High	High
Effectiveness	Not applicable	Low	Low	Moderate	High	Moderate	High	Low
Efficiency	Not applicable	Low	Low	Moderate	Moderate	Moderate	High	Low
Acceptability	Not applicable	Low	Low	Low	High	Low	High	Low

Plans effects are estimates of net overall changes from the "without project" condition:

++	very beneficial change	—	very adverse change
+	beneficial change	-	adverse change
0	no change		

5.14.1 Operational Flexibility Evaluation of Alternative Plans

The operational flexibility factors are measures of each alternative plan's abilities to satisfy the project objectives of restoration of historic hydrologic conditions in Taylor Slough, the elimination of damaging freshwater discharges to Manatee Bay/Barnes Sound and maintaining flood protection for the C-111 basin east of L-31N and C-111. There are 11 separate, but related, measures that were utilized to judge each plan's responsiveness to the operational flexibility evaluation factor as shown in Table 5-9. Alternative 8 was developed in conceptual detail only and was outside the scope of this project. Therefore, it was not evaluated as proposed. The plan was modified and is evaluated as alternative 6A.

All alternative plans restore more natural flows to the middle and lower portions of Taylor Slough. However, this area has been least impacted by the C&SF Project construction and operation.

All alternative plans will substantially reduce or eliminate the need for damaging freshwater discharges to Manatee Bay/Barnes Sound. Alternatives 1, 1A, 2, 6, 9, and 6A provide additional flood control discharge capacity at alternative locations upstream of S-176. As a result, flows into the lower section of C-111 will be reduced, thereby reducing the need for S-197 discharges. Additionally, all of these plans except alternative 1A include degrading the spoil mounds on the south bank of C-111 between S-18C and S-197. This also provides additional outlet capacity upstream of S-197. Alternatives 3 and 4 totally backfill lower C-111. Alternative capacity is provided at the east/ west spreader canal. This will have the effect of eliminating all S-197 discharges. Alternative 5 includes partial backfilling of lower C-111 with alternative discharge capacity provided at the east/west spreader canal. This will reduce the physical capacity for discharging water at S-197. Also, this plan includes increased upstream discharge capacity that would reduce inflows to the lower C-111.

Restoration of the headwaters and upper portions of Taylor Slough is critical to achieving overall restoration of historic conditions in all of Taylor Slough. This involves restoring the location, timing, and volumes of flows into this area. Alternatives 3 and 5 include no means of discharging water into the headwaters and upper Taylor Slough and therefore, do not satisfy this measure. Alternatives 1, 1A, and 2 include a small pump and canal at the location of Context Road to address this goal. However, the single location of discharges, the inability to control the timing of discharges, and the inadequate capacity resulted in these alternatives not satisfying this evaluation measure.

Table 5-9
Alternative Plan Evaluation Matrix

Evaluation Factors	Alternative Plans									
	1	1A	2	3	4	5	6	8	9	6A
OPERATIONAL FLEXIBILITY *	Not met	Not met	Not met	Not met	Met	Not Met	Met	NA	Met	Met
a. Maintain Natural Water levels along boundary of headwaters and upper Taylor Slough.	N	N	N	N	N	N	N	NA	N	Y
b. Control location of flows into: - Taylor Slough headwaters/upper - Taylor Slough middle portion	N Y	N Y	N Y	N Y	Y Y	N Y	Y Y	NA NA	Y Y	Y Y
c. Control timing of flows into: - Taylor Slough headwaters/upper - Taylor Slough middle portion	N N	N N	N N	N Y	N N	N N	N N	NA NA	N N	Y Y
d. Control flows to east-west spreader canal lands	Y	N	Y	Y	Y	Y	Y	NA	Y	Y
e. Minimize flows to Manatee Bay/Barnes Sound	Y	Y	Y	Y	Y	Y	Y	NA	Y	Y
f. Uniform sheetflow to lower Taylor Slough	Y	Y	Y	Y	Y	Y	Y	NA	Y	Y
g. Increase hydroperiods in headwaters and upper Taylor Slough	N	N	N	N	Y	N	Y	NA	Y	Y
h. Increase average depths in headwaters and upper Taylor Slough	N	N	N	N	Y	N	Y	NA	Y	Y
i. Maintain flood control in C-111 basin east of L-31N & C-111	Y	Y	Y	Y	Y	Y	Y	NA	Y	Y
ENVIRONMENTAL BENEFITS										
a. Increase hydrohabitat units	85%	NA	16%	79%	97%	85%	109%	NA	NA	109%
b. Increase species compatibility indices	7%	NA	10%	44%	51%	24%	44%	NA	NA	44%
COST EFFECTIVENESS Total Annual Cost ($ MILLION)	4.1	3.0	4.8	7.7	12.9	6.4	12.2	NA	14.6	12.0
FLOOD CONTROL IMPACTS Annual Flood Damage Reduction ($ MILLION)	3.2	3.2	3.0	2.9	2.9	2.9	2.9	NA	NC	2.9

* Operation flexibility evaluation factors are noted as follows:
N - Alternative plan does not satisfy evaluation factor
Y - Alternative plan does satisfy evaluation factor
NA - Not Applicable
NC - Not Computed

Alternatives 4, 6, and 9 include additional pumps that provide the ability to restore the historic location of flows to the headwaters and upper portions of Taylor Slough. These plans would, at least partially restore longer hydroperiods and water depths in the headwaters and upper portion of Taylor Slough. Alternative 6A also includes features that would enable the discharge of historic volumes of water at the proper locations into the area. It is the only alternative that would also enable maintaining higher water levels along the boundary of the headwaters and upper portion of Taylor Slough. This would be accomplished by allowing higher water levels and a wider range of water level fluctuations in the detention/retention area located adjacent to the ENP boundary. Alternative 6A is also the only alternative that would enable restoration of the historic timing of flows into the headwaters and upper portions of Taylor Slough. Water could be temporarily retained in the detention/retention area and discharged into Taylor Slough as appropriate.

Figures 5-25 through 5-36 provide graphical presentations of the base condition compared to alternative plans 1 through 6 with respect to water depth and hydroperiod. The data were derived using the SFWMM for 1976-1977, an average rainfall year. These data are summarized in Tables 5-10 and 5-11.

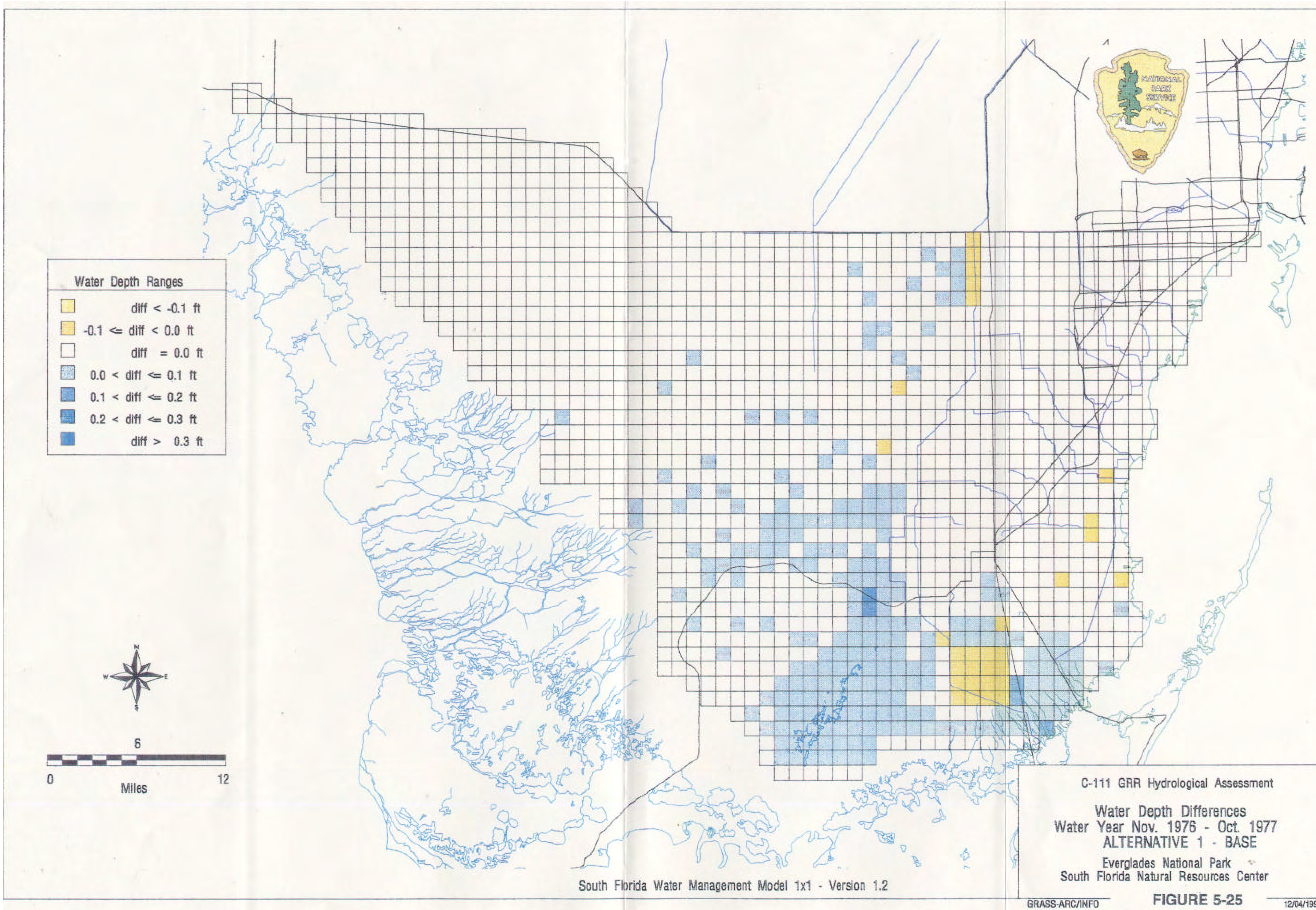
The differences between alternatives 6 and 6A are small enough that the hydrologic model utilized for this analysis cannot differentiate between them. The differences are within the one-square-mile grid size used for the model. Therefore, the model results for alternative 6 also apply to alternative 6A.

Table 5-10 shows that hydroperiods in Northeast Shark River Slough, Shark River Slough, and the Rocky Glades have been substantially increased with alternatives 4 and 6. Table 5-11 compares the Base Condition and alternatives 1,4, and 6 with respect to wet and dry season water depths. This table shows that both alternatives increase wet season water levels over a large area. However, dry season water levels are not greatly impacted.

Alternatives 4, 6, 9, and 6A, to varying degrees, enable restoration of historic flows to the headwaters and upper portions of Taylor Slough. Therefore, they all satisfy the evaluation measure for providing operational flexibility. Alternative 6A is the most effective at restoration of the headwaters and upper portions of Taylor Slough.

5.14.2 Cost Effectiveness Evaluation of Alternative Plans

The cost effectiveness of the alternative plans is measured by comparing the total annual costs. This includes the total project construction costs amortized over a 50-year project life and all annual operation, maintenance, repair, rehabilitation, and replacement costs. Table 5-12 summarizes the total annual costs of the alternative plans.



Water Depth Ranges
diff < -0.1 ft
-0.1 <= diff < 0.0 ft
diff = 0.0 ft
0.0 < diff <= 0.1 ft
0.1 < diff <= 0.2 ft
0.2 < diff <= 0.3 ft
diff > 0.3 ft
N
W
E
S
6
0
12
Miles
NATIONAL PARK SERVICE
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Water Depth Differences
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 1 - BASE
Everglades National Park
South Florida Natural Resources Center
GRASS-ARC/INFO
12/04/1993

FIGURE 5-25

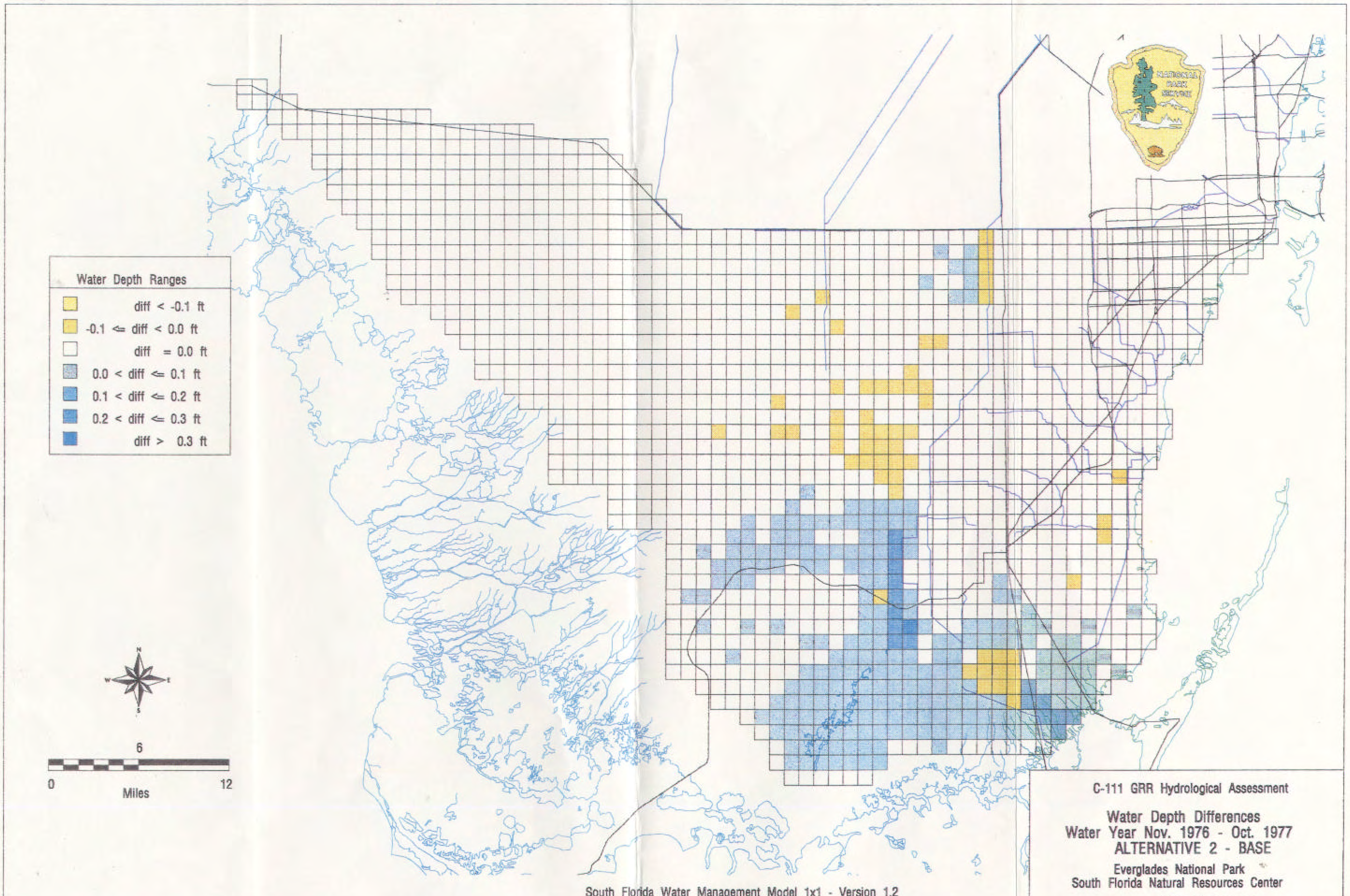
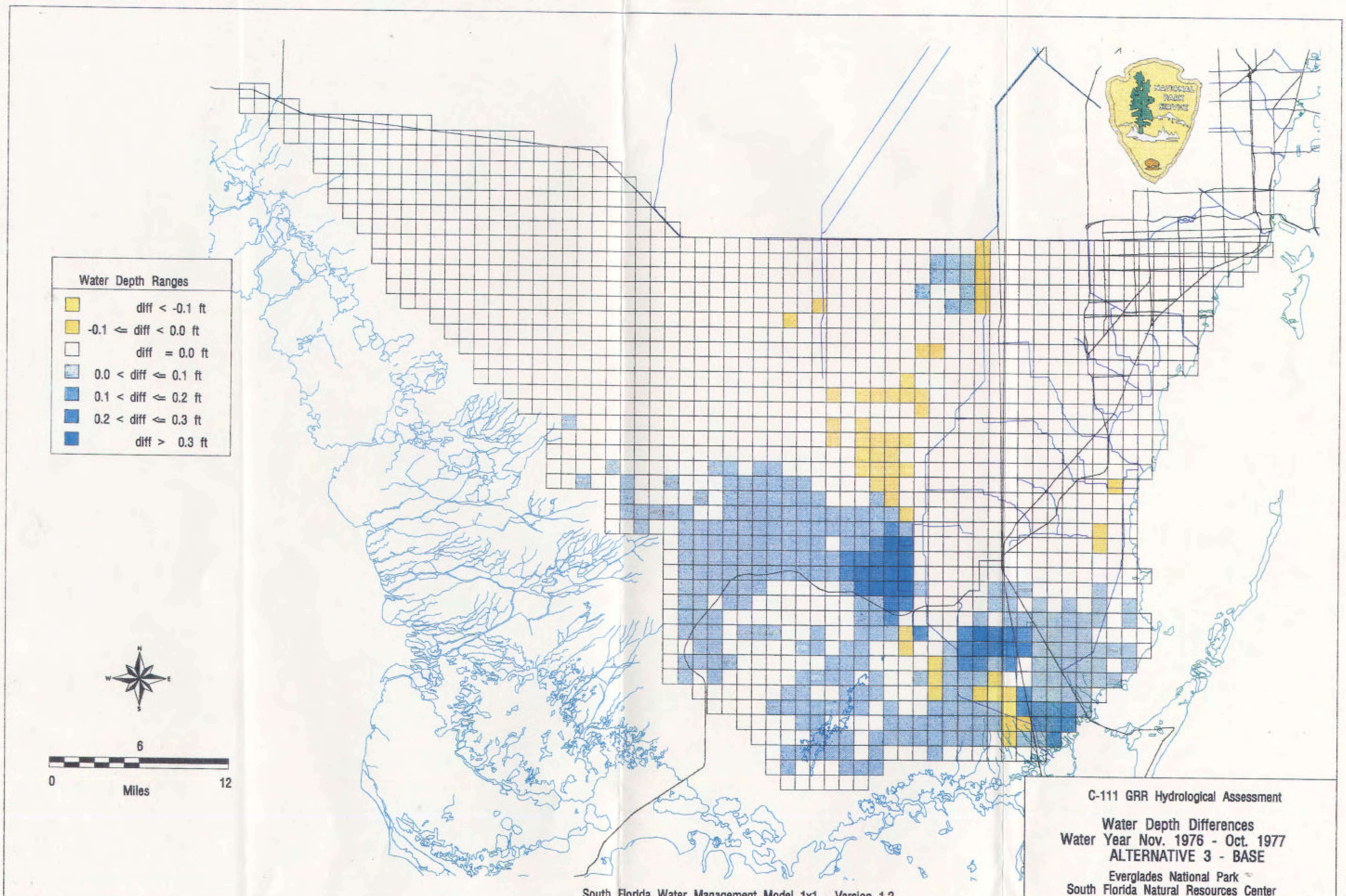

NATIONAL PARK SERVICE
Water Depth Ranges
diff < -0.1 ft
-0.1 <= diff < 0.0 ft
diff = 0.0 ft
0.0 < diff <= 0.1 ft
0.1 < diff <= 0.2 ft
0.2 < diff <= 0.3 ft
diff > 0.3 ft
N
W
E
S
6
0
Miles
12
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Water Depth Differences
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 2 - BASE
Everglades National Park
South Florida Natural Resources Center
GRASS-ARC/INFO
12/04/1993

FIGURE 5-26



C-111 GRR Hydrological Assessment

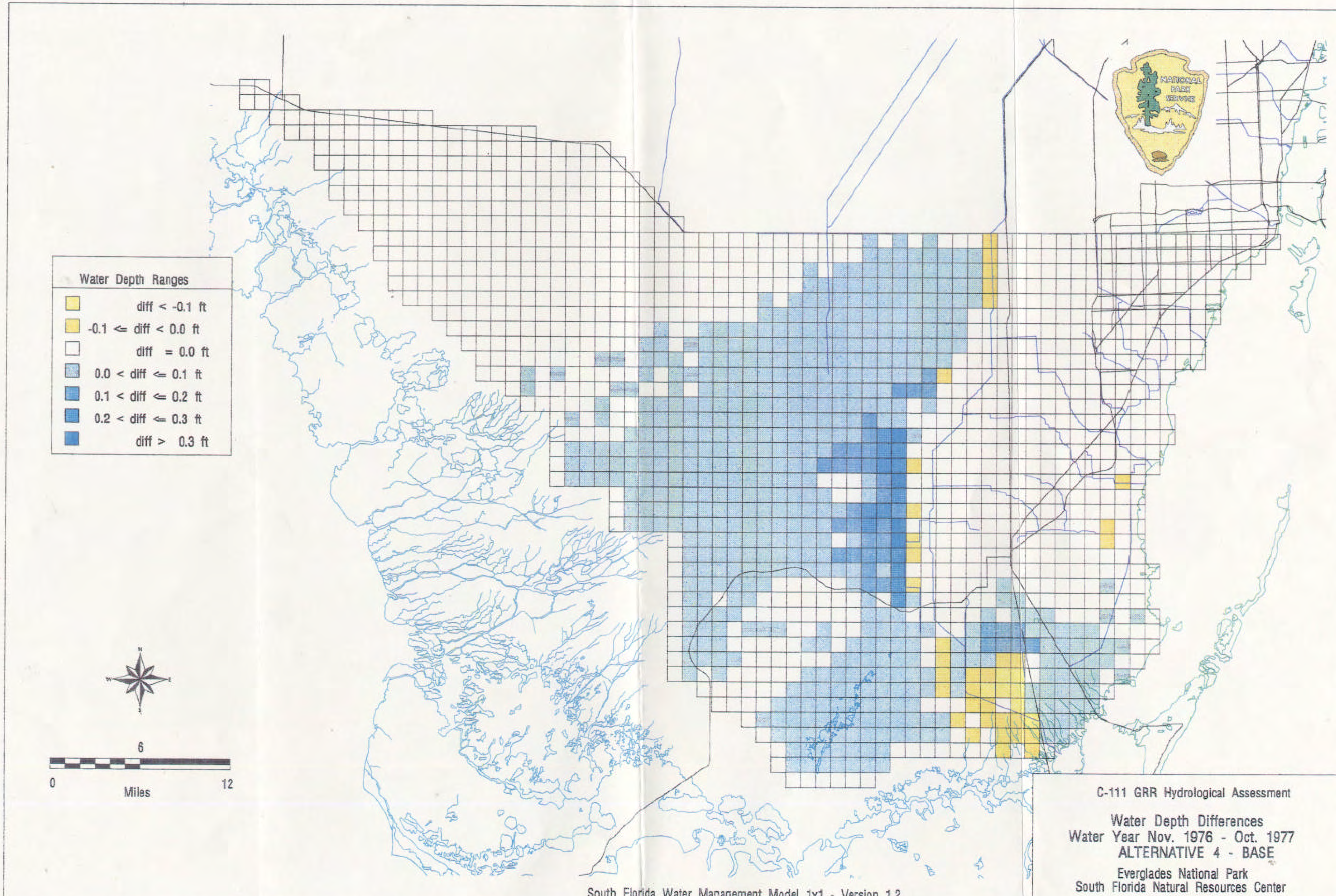
Water Depth Differences
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 3 - BASE

Everglades National Park
South Florida Natural Resources Center

GRASS-ARC/INFO

FIGURE 5-27

12/04/1993



C-111 GRR Hydrological Assessment

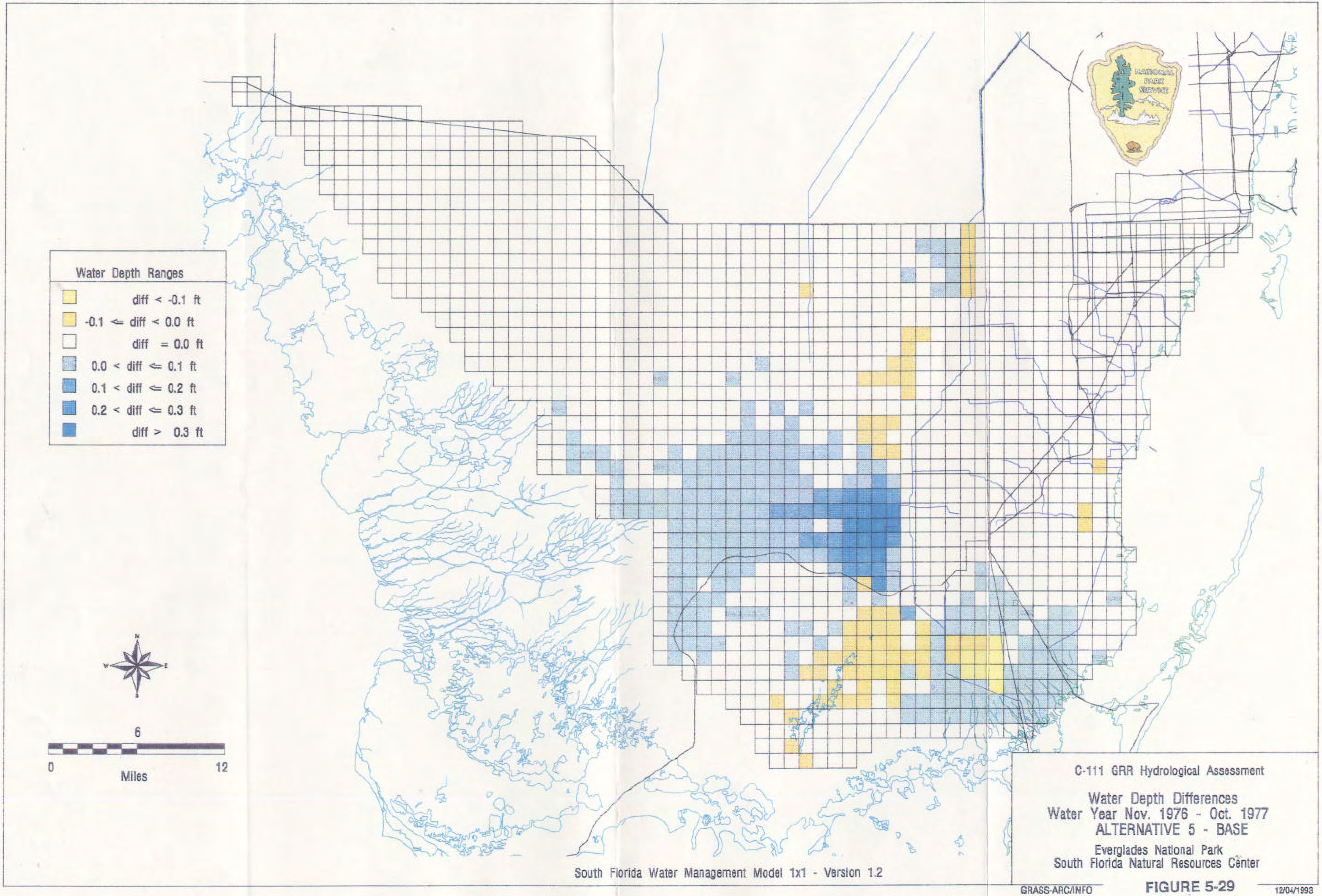
Water Depth Differences
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 4 - BASE

Everglades National Park
South Florida Natural Resources Center

GRASS-ARC/INFO

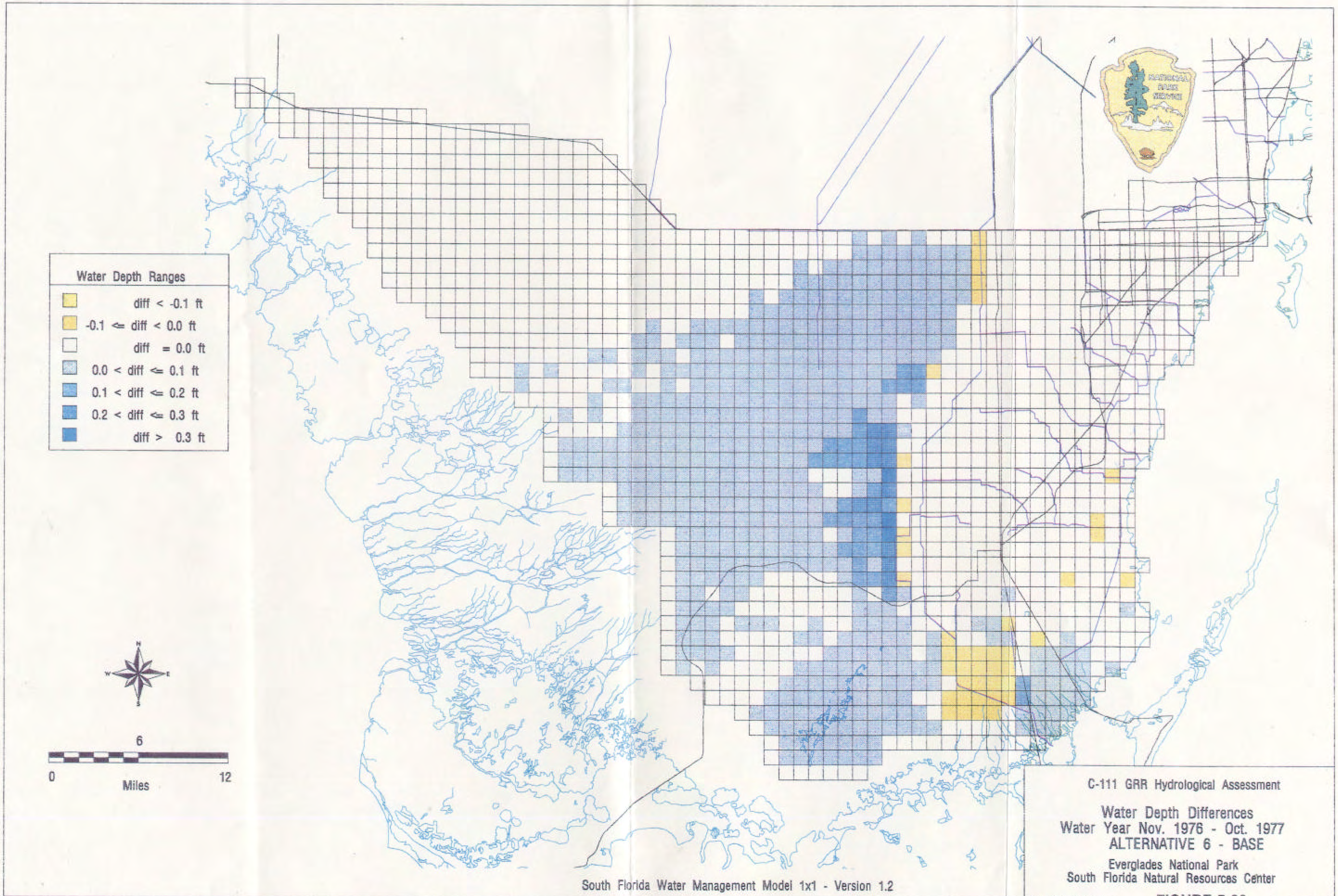
FIGURE 5-28

12/04/1995



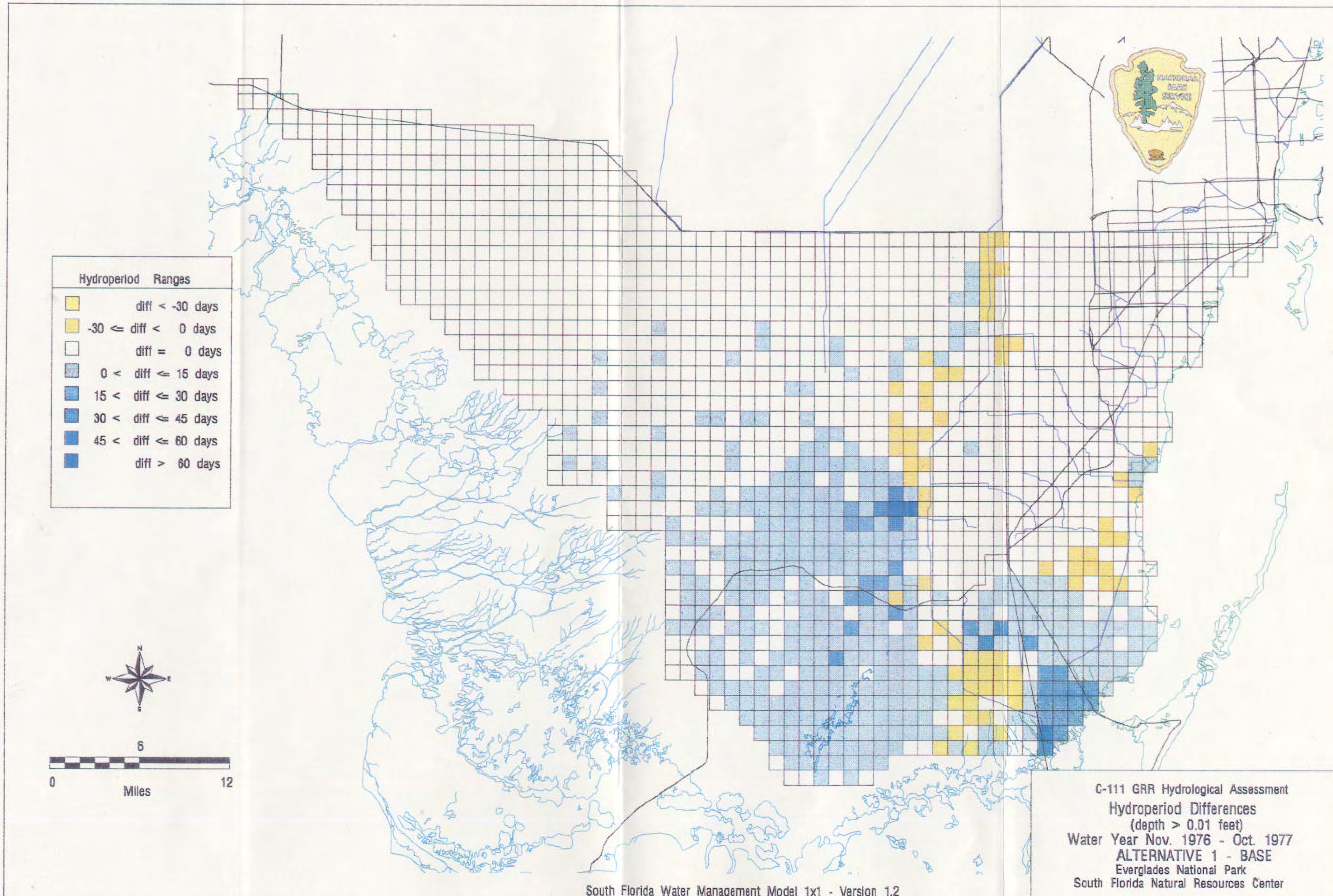
Water Depth Ranges
diff < -0.1 ft
-0.1 <= diff < 0.0 ft
diff = 0.0 ft
0.0 < diff <= 0.1 ft
0.1 < diff <= 0.2 ft
0.2 < diff <= 0.3 ft
diff > 0.3 ft
6
0
Miles
12
NATIONAL PARK SERVICE
C-111 GRR Hydrological Assessment
Water Depth Differences
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 5 - BASE
Everglades National Park
South Florida Natural Resources Center
South Florida Water Management Model 1x1 - Version 1.2
GRASS-ARC/INFO
12/04/1993

FIGURE 5-29



Water Depth Ranges
diff < -0.1 ft
-0.1 <= diff < 0.0 ft
diff = 0.0 ft
0.0 < diff <= 0.1 ft
0.1 < diff <= 0.2 ft
0.2 < diff <= 0.3 ft
diff > 0.3 ft
N
W
E
S
6
0
Miles
12
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Water Depth Differences
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 6 - BASE
Everglades National Park
South Florida Natural Resources Center
GRASS-ARC/INFO
12/04/1993

FIGURE 5-30

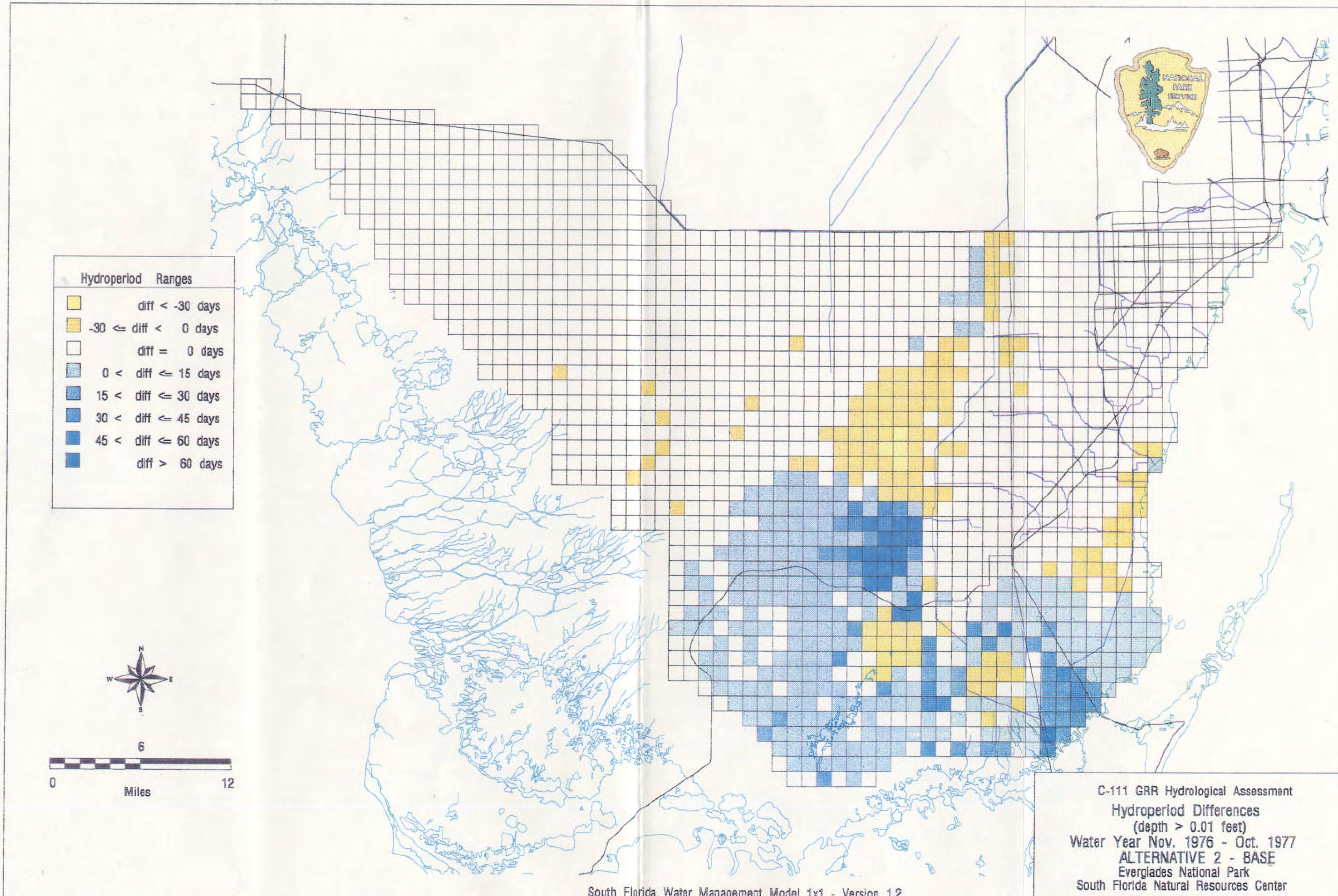


C-111 GRR Hydrological Assessment
Hydroperiod Differences
(depth > 0.01 feet)
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 1 - BASE
Everglades National Park
South Florida Natural Resources Center

GRASS-ARC/INFO

FIGURE 5-31

12/06/1993

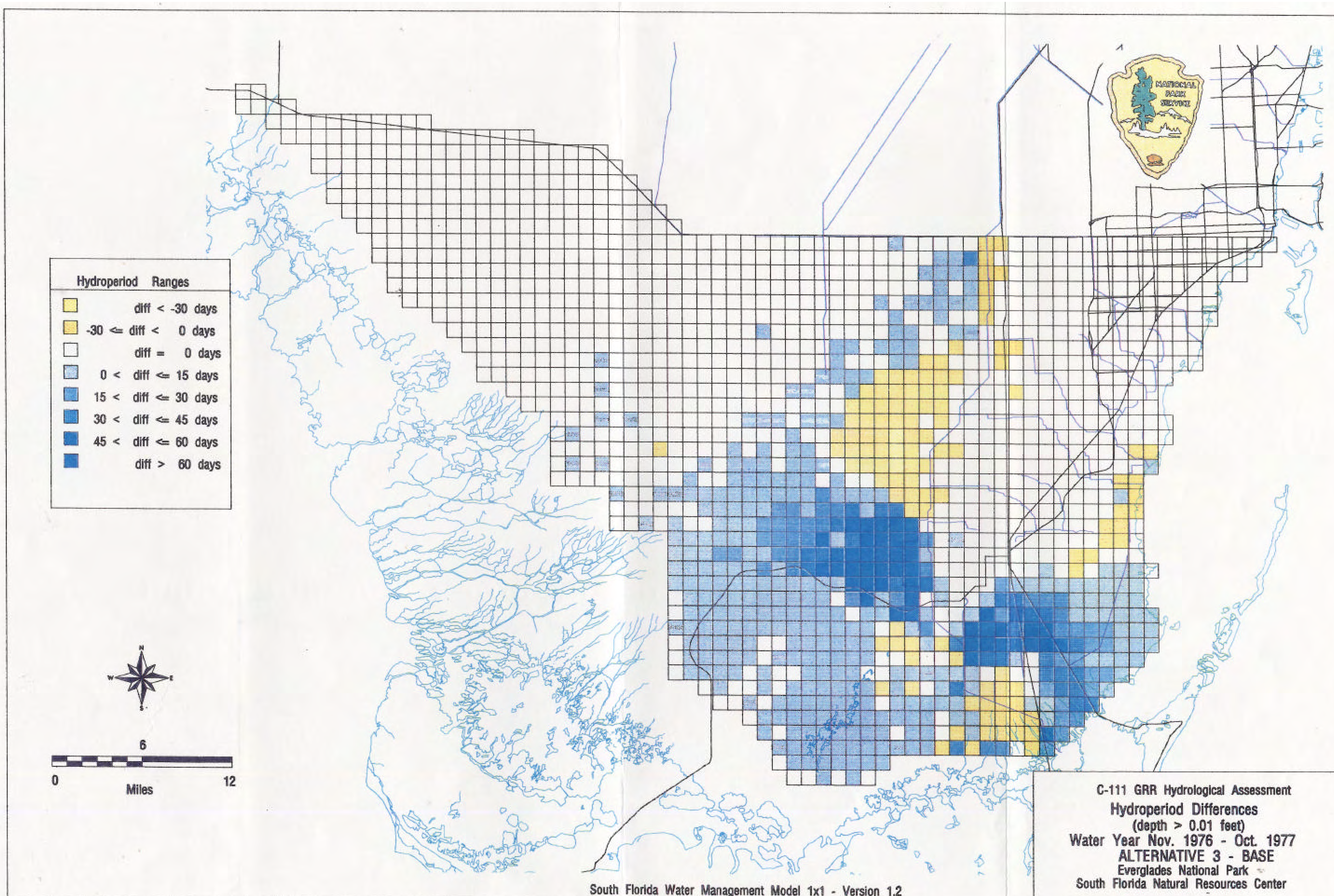


C-111 GRR Hydrological Assessment
Hydroperiod Differences
(depth > 0.01 feet)
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 2 - BASE
Everglades National Park
South Florida Natural Resources Center

GRASS-ARC/INFO

FIGURE 5-32

12/06/1993



Hydroperiod Ranges
diff < -30 days
-30 <= diff < 0 days
diff = 0 days
0 < diff <= 15 days
15 < diff <= 30 days
30 < diff <= 45 days
45 < diff <= 60 days
diff > 60 days
NATIONAL PARK SERVICE
N
W
E
S
6
0
Miles
12
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Hydroperiod Differences
(depth > 0.01 feet)
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 3 - BASE
Everglades National Park
South Florida Natural Resources Center
GRASS-ARC/INFO
12/06/1993

FIGURE 5-33

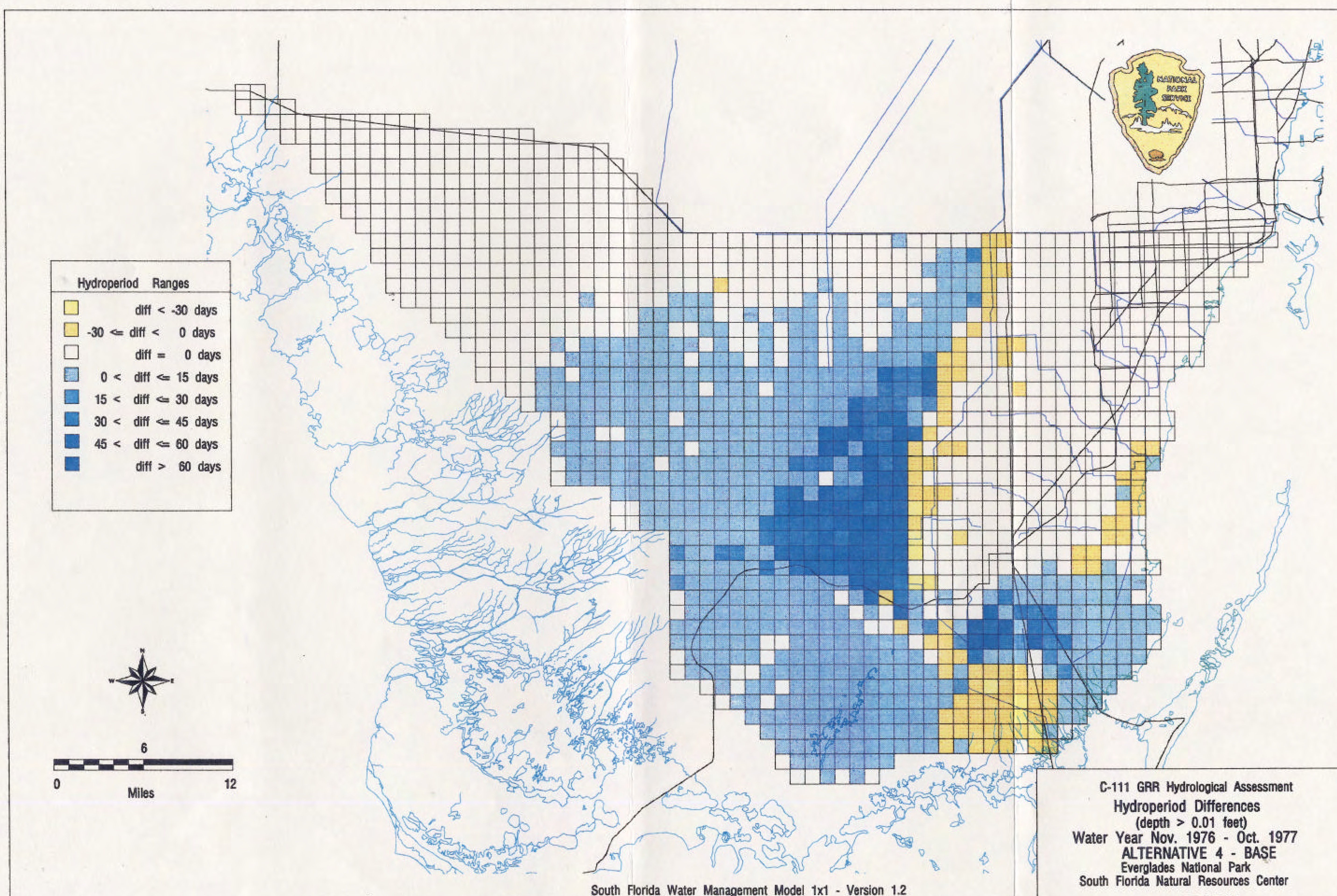
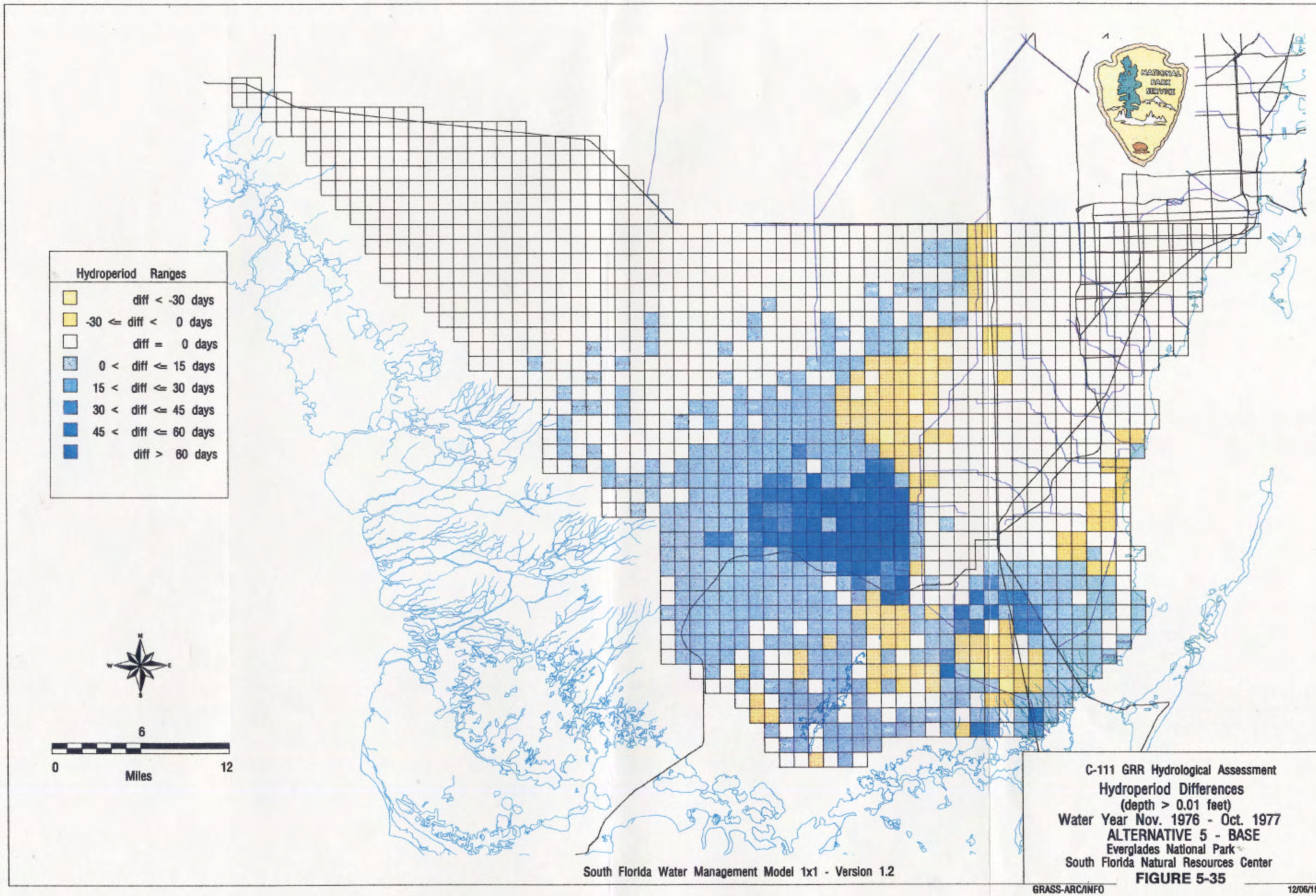
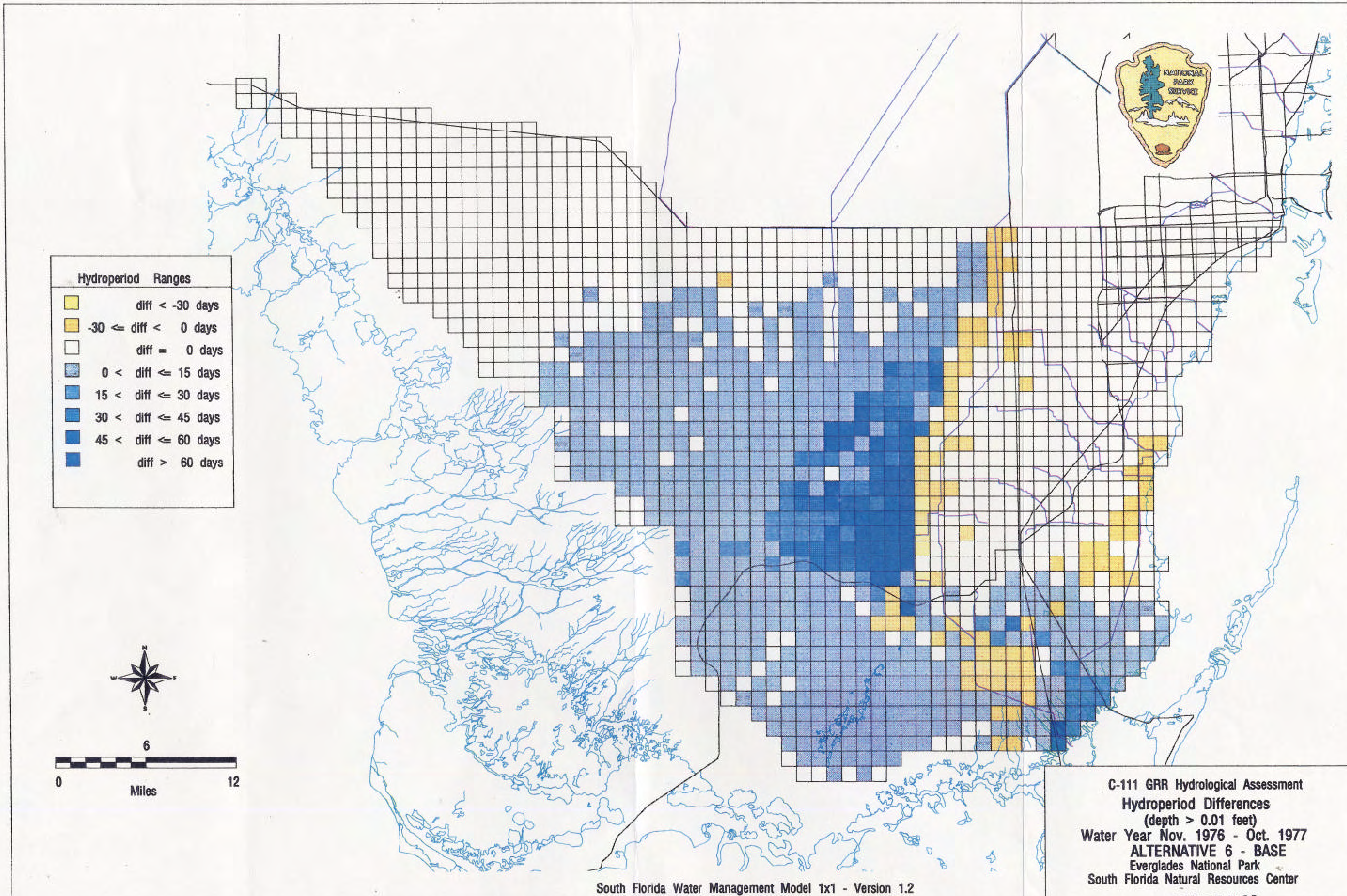

Hydroperiod Ranges
diff < -30 days
-30 <= diff < 0 days
diff = 0 days
0 < diff <= 15 days
15 < diff <= 30 days
30 < diff <= 45 days
45 < diff <= 60 days
diff > 60 days
6
0
12
Miles
NATIONAL PARK SERVICE
C-111 GRR Hydrological Assessment
Hydroperiod Differences
(depth > 0.01 feet)
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 4 - BASE
Everglades National Park
South Florida Natural Resources Center
South Florida Water Management Model 1x1 - Version 1.2
GRASS-ARC/INFO
12/06/1993

FIGURE 5-34


NATIONAL PARK SERVICE
Hydroperiod Ranges
diff < -30 days
-30 <= diff < 0 days
diff = 0 days
0 < diff <= 15 days
15 < diff <= 30 days
30 < diff <= 45 days
45 < diff <= 60 days
diff > 60 days
N
W
E
S
6
0
Miles
12
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Hydroperiod Differences
(depth > 0.01 feet)
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 5 - BASE
Everglades National Park
South Florida Natural Resources Center
FIGURE 5-35
GRASS-ARC/INFO
12/06/1993



C-111 GRR Hydrological Assessment
Hydroperiod Differences
(depth > 0.01 feet)
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 6 - BASE
Everglades National Park
South Florida Natural Resources Center

GRASS-ARC/INFO **FIGURE 5-36** 12/06/1993

Table 5-10
Hydroperiod Changes in the Subbasins

Average year 1976–1977			Depth > 0.01			
Change	A1-Bse	A2-Bse	A3-Bse	A4-Bse	A5-Bse	A6-Bse
			Northeast Shark Slough			
less	0	1	0	0	0	0
none	99	104	82	55	80	60
more	12	6	29	56	31	51
			Shark Slough			
less	0	3	0	0	0	0
none	53	63	34	2	20	2
more	25	12	44	76	58	76
			Rocky Glades			
less	12	53	46	9	34	9
none	53	34	22	4	9	5
more	69	47	66	121	91	120
			Upper Eastern Panhandle			
less	12	9	6	15	18	15
none	6	6	5	2	3	4
more	32	35	39	33	29	31
			Lower Eastern Panhandle			
less	10	2	13	23	6	7
none	11	10	6	1	7	3
more	15	24	17	12	23	26
			Upper Taylor Slough			
less	1	0	1	6	0	6
none	1	1	0	1	0	1
more	21	22	22	16	23	16
			Lower Taylor Slough			
less	0	14	7	1	19	4
none	3	15	8	5	17	3
more	81	55	69	78	48	77

Table 5-11
Changes in Ponding Depth in the Subbasins

	Average year 1976–1977			Water Depth		
	Dry Season - April			Wet Season - October		
Change	[illegible]-Bse	A4-Bse	A6-Bse	A1-Bse	A4-Bse	A6-Bse
			Northeast Shark Slough			
less	0	0	0	0	0	0
none	108	79	86	73	1	1
more	3	32	25	38	110	110
			Shark Slough			
less	0	0	0	0	0	0
none	78	53	53	55	0	0
more	0	25	25	23	78	78
			Rocky Glades			
less	0	0	0	2	0	0
none	134	134	134	75	22	22
more	0	0	0	57	112	112
			Upper Eastern Panhandle			
less	0	0	0	15	11	24
none	50	50	50	9	4	9
more	0	0	0	26	35	17
			Lower Eastern Panhandle			
less	1	1	0	3	8	7
none	35	35	32	6	3	9
more	0	0	4	27	25	20
			Upper Taylor Slough			
less	0	0	0	2	4	4
none	23	23	23	4	2	2
more	0	0	0	17	17	17
			Lower Taylor Slough			
less	0	1	1	0	0	0
none	80	79	81	4	4	4
more	4	4	2	80	80	80

Table 5-12
Preliminary Analysis of Annual Benefits and Costs
Alternative Designs

ITEM	ALT 1	ALT 1A	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 8	ALT 9	ALT 6A
Initial Cost	36,816,000	26,502,000	45,671,000	74,772,000	128,326,000	62,087,000	121,929,000	NC	179,196,000	121,413,000
Interest During Construction	8,024,000	5,760,000	8,506,000	12,070,000	17,053,000	9,283,000	15,648,000	NC	NC	15,534,000
TOTAL INVESTMENT COST	44,840,000	32,262,000	54,177,000	86,842,000	145,379,000	71,370,000	137,577,000	NC	NC	136,947,000
Interest & Amortization	3,665,000	2,637,000	4,429,000	7,099,000	11,884,000	5,834,000	11,246,000	NC	NC	11,194,000
Operation & Maintenance	358,000	354,000	385,000	536,000	935,000	479,000	892,000	NC	NC	748,000
Annualized Replacements	34,000	34,000	35,000	70,000	68,000	41,000	54,000	NC	NC	97,000
TOTAL ANNUAL COST	4,057,000	3,025,000	4,848,000	7,705,000	12,886,000	6,354,000	12,192,000	NC	14,648,000	12,039,000
TOTAL ANNUAL BENEFITS	3,179,000	3,179,000	2,969,000	2,906,000	2,906,000	2,906,000	2,906,000	NC	NC	2,906,000

5.14.3 Flood Control Impact Evaluation of Alternative Plans

Consistent with the original design of the south Dade County Flood control features and subsequent modifications to the system, the design of all alternatives utilize S-173/S-331 as a divide structure under flood conditions. All project features will convey runoff from the C-111 basin without inflows from S-331/S-173 during a design storm. During non-flood conditions, S-331 could pass flows into C-111.

All the alternatives were based on the premise that they would maintain the existing protection to the agricultural area. However, all alternative plans provide increased flood protection when compared to the existing project operated at the design optimum canal levels. Each of the seven alternatives basically provide similar hydrologic and hydraulic responses, therefore, only one major economic investigation was conducted. However, slight differences in flood damage effects for the plans are noted since some of the plans require different quantities of land purchases.

Alternative 1 requires no land purchases in the Frog Pond area. Alternative 2 is evaluated with the western three sections of the Frog Pond removed from production. Alternatives 3, 4, 5, 6, and 6A are evaluated with the entire Frog Pond removed from production. Alternatives 4, 6, and 6A also include the acquisition of the Rocky Glades (buffer zone) agriculture area. Alternative 1A is essentially the same as alternative 1 with the exception of the east-west spreader canal and plugs. An in-depth evaluation indicated that all alternatives would improve flood drainage in the study area and substantially reduce flooding durations, dollar damages, and crop land flooded during the 10-year and 2-year storm events. Since all alternatives provide the same level of flood protection, the flood damage reduction of all plans could be quantified using alternative 1A. Alternative 1A has a project cost of $26,502,000 with an annual cost of $3,025,000 at 8 percent and annual benefits of $3,179,000. The benefit to cost ratio of alternative 1A is 1.05 to 1.0.

A cost comparison of all alternatives is shown in Table 5-12.

5.14.4 Identification of the Recommended Plan

The plan that produces the greatest benefit to the environment while providing flood damage prevention capability within the study area is alternative 6A.

All alternative plans would satisfy the project objective of maintaining flood damage prevention capacities in the study area.

Satisfying the performance measure of operational flexibility is essential to meeting the project objectives of restoration of historic hydrologic conditions in the C-111 basin and Taylor Slough and reducing damaging freshwater discharges to Manatee Bay/Barnes Sound.

Four alternatives satisfied the operational flexibility measure, alternatives 4, 6, 9, and 6A. Of these alternatives, alternative 6A was the most effective by providing the ability to maintain higher water levels along the boundary of the headwaters and upper portions of Taylor Slough and by providing the capability to control the timing of discharges into Taylor Slough.

Of the four alternative plans that satisfied the operational flexibility criteria, alternative 6A was the least cost alternative. Therefore, it is judged to be the most cost effective.

SECTION 6

ENVIRONMENTAL EFFECTS OF RECOMMENDED PLAN

6.1 PHYSICAL FORM

The considered plans are intended to create a more natural physical environment in the Taylor Slough and C-111 basins. Water is to be held at optimum canal stages to prevent drainage of adjacent wetlands. Excess water will be pumped into the system above Taylor Slough so that it will sheet-flow southward, feed the slough, and restore a more natural hydroperiod to the marl prairie. Water will be allowed to drain southward into the lower C-111 basin. Provision of adequate water to the system, by means including the Modified Water Deliveries to Everglades National Park Project, will cause regeneration of the sawgrass-muhly grass prairies and reclamation of wet prairie land from invading exotic and native shrubs and trees. The restored physical habitat would make possible the return of masses of the wading birds that formerly inhabited the southeast Everglades.

6.2 HYDROLOGY

Hydrologic impacts of the recommended plan (Plan 6A) differed from the other plans most significantly by the physical distribution of the pump capacity along a north-south line of protection between the Everglades National Park and the agricultural lands east of L-31. Since the hydraulic gradient of the groundwater system slopes to the southeast, Shark River Slough discharges into the northern border of the Park are reduced as they transition from surface water flow below Tamiami Trail to groundwater flow in the Park. The impact of having an extended area of pumped discharges in Plan 6A causes higher groundwater levels along the eastern border of the Park with resultant loss in hydraulic slope away from Shark River Slough and an increase in total volume remaining in the slough.

Under existing conditions the C-111 area has about 2,765 cfs discharge capacity. During the 1988 flood control study, the selected plan raised this capacity to approximately 3,130 cfs. Plan 6A recommends 4,015 cfs, with the additional 400 cfs needed for seepage control along L-31. Soil moisture storage in the initial 1.5 feet of unsaturated ground above the water table provides about 3.6 inches of rainfall storage. The remaining volume of the 10-year, 5-day storm is removed by project structures.

The wide aerial extent of the water distribution capability of Alternative 6A restores the hydrology in 128 square miles of the Taylor Slough and its headwaters in the Rocky Glades. In addition, the hydroperiod and depths in 1027 square miles of Shark River Slough are beneficially impacted by the higher stages in the Rocky Glades, resulting in a net increase in water volume within Shark River Slough. The aerial extent of the increase in hydroperiod is shown on Figure 5-36. During flood periods, the 1200 cfs of additional pump capacity will retain in Everglades National Park over 2300 acre feet per day of water that would have previously been diverted to tide water. These waters will eventually runoff into or infiltrate to Florida Bay at a rate more consistent with the historic natural timing.

6.3 ENVIRONMENTAL RESOURCES

6.3.1 Everglades National Park

The goal is restoration of the southeastern wet prairie Everglades, including southeastern Everglades National Park. The recommended plan would have the hardware and earthworks needed to provide for a 5 month to 7 month hydroperiod during which water covers the land surface to depths of 2 inches to 20 inches and seldom drops as much as 29-30 inches below ground surface. These conditions are those that produce abundant fresh water shrimp, crayfish and warm water fishes that proliferate during the wet season and become concentrated in drying pools during the dry season. Then they are prey for roseate spoonbills, wood storks, herons and egrets that may become re-established on their historic nesting and feeding grounds in and around Everglades National Park.

Improvements in the wet prairie ecosystem and in Taylor Slough attributable to Alternative 6A (Table 5-6) indicate that this alternative has the capacity to provide the hydrologic conditions requisite to a restored ecosystem in the southeastern Park. When modeled under the current design optimum water levels, (prior to the interim test), about 1,155 square miles of Everglades habitat, mostly within the Park, are benefitted by increased hydroperiod at optimum levels under Alternative 6A.

6.3.2 Shark River Slough East and West Basins

Alternative 6A has the capability, given an augmented water supply, of providing for the environmentally beneficial hydroperiods (periods when water levels are at or above ground level) that are interrelated in eastern and western Shark River Slough, the Rocky Glades, Taylor Slough (including the southeastern Frog Pond), and the western and eastern C-111 basins. Alternative 6A produces a 100 percent improvement over the base condition and maintains a slightly higher elevation of dry season, sub-surface water in both east and west basins. It also increases water supply to the expanded portion of ENP in the north part of the west basin.

Of the considered alternatives, the recommended plan, 6A, is that which would contribute most toward restoring the hydrological and ecological linkage between Shark River Slough and the Taylor Slough--C-111 basin. This alternative contributes positively to the hydroperiod and water depths, not only in the short-hydroperiod glades southeast of Shark Slough, but well into the Slough itself. Alternative 6A provides for water distribution in the headwaters of Taylor Slough that is necessary for surface water inundation during wet periods when water in Shark Slough overflows the rocky ridges into Taylor Slough, thereby influencing the latter's hydroperiod. This would benefit species with relatively large spatial requirements (snail kite, wading birds) that are dependent on the combined habitat conditions of both basins for their survival. The short-hydroperiod marl prairies, with adequate water supply, could once again serve as essential early dry season foraging areas for Park-wide populations of wading birds.

6.3.3 The Rocky Glades

Restored water supply and Alternative 6A's capacity for distributing water into the Rocky Glades would help restore the Rocky Glades' function as hydrologic barrier between Shark Slough waters and the headwaters of Taylor Slough. The Rocky Glades would continue to represent a transition area between the deep slough areas and seldom flooded uplands. Those portions of the Rocky Glades that have been rock plowed, however, will not become useful wildlife habitat. The probable scenario in these short-hydroperiod, transitional wetlands is that they will be dominated with Brazilian pepper. Management and plant control efforts would be necessary.

6.3.4 Taylor Slough

The recommended alternative's capability of distributing restored water supplies with the natural timing associated with historical wet and dry seasons, can provide for sheetflows throughout Taylor Slough and into the downstream areas of Florida Bay. This assumes that restored water supplies are forthcoming as the cumulative effects of Modified Water Deliveries, augmented flow from Lake Okeechobee, and the C-111 project.

6.3.5 The Frog Pond

The portions of the Frog Pond that are removed from agriculture as a result of the C-111 project will likely be invaded by Brazilian pepper. The artificial "soil" created by the practice of rock plowing and fertilization apparently is inhospitable to most native plant species, even many years after agricultural abandonment. Virtually nothing but stands of Brazilian pepper (*Schinus terebinthifolius*) will colonize. As wildlife habitat, abandoned rockplowed uplands are of little value.

6.3.6 The Marl Glades

Alternative 6A has the potential for delivering water high in the Rocky Glades, into Taylor Slough and south of lower C-111 in quantities and with the timing that contribute to 100 percent-improved habitat quality. This alternative maintains dry season, sub-surface water at higher elevations in both east and west basins and increases water supply to the north part of the west basin. As measured, using the design water management schedule, all alternatives produce drier than optimum marl habitat conditions. In dry season, water levels drop at least 12 inches below the ground surface, where water is held in solution cavities, in water control structure receiving basins, and, perhaps, in alligator holes. Even with a more natural water supply, the marl glades would dry out in winter months. Natural dry season events would result in a concentration of small fishes, frogs, and invertebrates that would attract concentrations of wading birds, including the endangered wood stork.

6.3.7 Florida Bay, Barnes Sound, and the Coastal Mangrove Fringe

The recommended alternative would substantially reduce or eliminate the need for damaging freshwater discharges to Manatee Bay/Barnes Sound. Water would be re-directed to northeast Florida Bay. With the availability of an adequate supply of water, the natural timing and distribution of sheetflows throughout Taylor Slough would benefit Florida Bay. Elevated ground water levels in the Taylor Slough basin would contribute to the reduction of the tendency toward hypersaline conditions in northern Florida Bay. Restoration of a more natural hydrology will correct one of the major problems in the Bay. It is not known whether this alone will restore Florida Bay, but it is unlikely that restoration will occur without the natural fresh water increment from the Everglades.

6.4 THREATENED OR ENDANGERED SPECIES

Cape Sable sparrow

ENP researchers have Cape Sable sparrow data that suggest that nesting is reduced when surface water is present in the colony sites during the February to June nesting season. The best condition has the smallest flooded area in the marl prairie habitats during the nesting months. These criteria are met fairly well under the existing condition, and none of the evaluated alternatives would change this very much. One to 2 square-mile cells may be flooded less than 0.5 inch deep during part of the nesting season now and under all the alternatives. None of the considered alternative actions would adversely affect the sparrow. The FWS, in its role under the Endangered Species Act, has found that the alternatives pose little threat to the sparrow, but the Service believes that consultation under the Act may be necessary when a detailed operational plan is formulated (Annex D).

Snail kite

The study area canals may provide foraging habitat for the snail kite, but potential nesting sites are restricted. The area is a short-hydroperiod habitat, not favorable for the snail's prey, the apple snail. None of the alternatives would change this condition, and the snail kite will be essentially unaffected by the considered project. The FWS has found the alternatives not likely to affect the snail kite.

Wood stork

Alternative 6A provides more area with the wood stork's required hydroperiod by over 40 percent, compared to existing conditions. Although the habitat improvement is marginal, the considered alternatives will not affect the wood stork. The FWS concurs.

Bald eagle

Bald eagles nest in the southern part of the study area and feed along the coastal lagoons, bays and, probably, in the lower reach of C-111. Projected effects of considered alternatives would not adversely affect bald eagle habitat. Nesting sites, including coastal mangroves, would not be altered by project alternatives, nor would foraging areas be at all degraded. The FWS concurs with the Corps finding that there would be no effect on bald eagles from implementation of any of the alternatives.

Indigo snake

The eastern indigo snake inhabits high, dry, sandy areas also favored by gopher tortoises. The snake may hunt along canal banks and disposal berms. The considered alternatives are intended to restore historic Everglades habitat, and the snake does not use that aquatic environment to any great extent. The FWS concurs that no effect will occur to the eastern indigo snake as a result of the considered action.

Florida panther

The panther ranges within the Fakahatchee Strand, Big Cypress Fresh Water Preserve, and ENP. It is expected to habituate areas populated by whitetail deer, although it preys on upland mammals and birds, including armadillo, wild turkey and occasional domestic livestock. Considered alternative actions would not adversely modify habitat for panthers, and the considered project would have no effect. The FWS concurs.

American Crocodile

The studied alternatives are intended to provide more over land flow of fresh water into Florida Bay. To the extent that they do so, the alternatives would not cause adverse effects to the salinity regime in the crocodile's habitat. Flood-water releases through C-111 during the nesting season, April to August, could adversely affect nesting by drowning the nests, but the alternatives are intended to divert flood waters from C-111 to over land flows. Based on these considerations, we have determined that the alternative actions would not affect the American crocodile, and the FWS concurs.

6.5 VECTORS

Mosquitoes and biting flies spend part of their life-cycle in water, and the studied project would increase the area of standing or slowly moving water. Concurrently, increased populations of mosquito fish (*Gambusia*) and other insectivorous fishes as well as insectivorous insects and spiders are expected in the slough and marl prairie. Swallows, swifts and bats will take their toll on flying insects. The net effect is expected to be a dynamic balance, not unusual in a natural system. Ticks will continue to be carried in the wild animal population. No significant incidence of Lyme's disease is recorded for the Taylor Slough and C-111 basins.

6.6 WATER QUALITY

As discussed in section 2.3, nutrient enrichment resulting primarily from agricultural runoff is the major water quality problem in the Everglades. Although nutrients levels are low in the Taylor Slough drainage they frequently exceed targets established for the input points at S-332, S-175, and S-18C. The water delivery systems discussed in this report are not specifically designed to address nutrients; however those that incorporate retention areas or flow-ways may have a beneficial water quality impact. Such benefits will not be those associated with conventional water retention bodies over classical soil types, since the subsurface in the study area is very porous, cavity-riddled, limestone. Only when the ground water is high would water stand on the surface, allowing nutrient-adsorbing particulates to settle from the water column.

6.7 WATER SUPPLY

Under present conditions, the entire study area suffers from inadequate water supply during average and dry periods. Under the study conditions, the alternatives at least partially restore historic water patterns. Alternative 6A restores needed water distribution patterns and improves the wet prairie habitat by 100 percent over existing conditions.

6.8 AGRICULTURE

Environmental benefits to the project objectives related to removing lands from agricultural production as a part of the recommended plan include enabling the maintenance of higher water levels along the boundary of the headwaters and upper portion of Taylor Slough; allowing the discharge of water to Taylor Slough in the historic locations; enabling the proper timing of water flows to Taylor Slough; and reducing the drainage of Taylor Slough through seepage into the L-31N borrow canal. There may be incidental benefits to water quality related to removing the Frog Pond and Rocky Glades agricultural lands from agricultural production. The natural groundwater movement is through these agricultural areas to the southeast toward the canal. This water is collected in the canal and will be returned to ENP with the recommended plan. Therefore, if agricultural use of this land is increasing the nutrient concentrations, or otherwise contaminating water that enters the canal, the recommended plan will reduce these problems. Additionally, the detention/retention zone included in the recommended plan will be located on former agricultural land. It will provide for filtration of the water as it flows through wetland vegetation and groundwater movement before it is discharged into ENP.

Eliminating flood damages requires land purchases in the Frog Pond and Rocky Glades agricultural areas located in the south-west portion of the economic area. An in-depth evaluation indicated that the recommended plan would improve flood drainage in the study area and substantially reduce flooding durations, dollar damages, and crop land flooded during the 10-year and 2-year storm events.

It can be expected that canal stages will return to higher design levels with or without project implementation. Environmental restoration efforts will raise water levels in the ENP. With the recommended plan, the resultant hydrologic profile between the ENP and C-111 will be higher than the without project profile. The loss of groundwater storage from the higher profile will reduce the flood protection west of L-31N and the C-111 canal. Areas affected include the Frog Pond located just east of L-31W in the southwest area of the basin and the Rocky Glades area west of L-31N located in the East Everglades Area. Therefore, a requirement of the recommended plan is that these lands be purchased.

In the Frog Pond, acreage under cultivation has historically varied depending upon stages in the canal system. Information provided by Larsen and Associates used in this study shows the total acreage of the area to be somewhat higher than 4,900 acres with tree islands and sloughs omitted. Of this acreage, approximately 2,800+ acres are in tomato production.

If the Frog Pond is removed from production, it is estimated approximately 3,920,000 cartons or approximately 98,000,000 lbs, (980,000 CWT) of tomato production would be lost annually. This information is based upon an average Dade County yield of 1,400 cartons per acre at 25 lbs per carton. Direct losses to producers (profit) in the Frog Pond are estimated to be between $6.8 million and $10.8 million annually. This information is based upon a loss between $2,442 and $3,842 per acre at an average price of $8.95 per carton. These estimates can be interpreted as an average net return to land and management on a per acre basis with the exception that no managerial labor costs have been removed from these estimates. Although the average price per carton was $8.95 for Florida in 1991-1992, seasonal prices have wide historical fluctuations which have extreme impacts upon net returns. Seasonal prices for tomatoes in Florida varied between $4.18 and $20.18 per carton ir 1991-1992. Cost and return information for Dade County indicate it is difficult to cover operating and fixed expenses at price levels below $6.00 a carton. [1]

The existing flood control project does not guarantee water control west of the levee in the Rocky Glades agricultural area. Since, additional drainage is not allowed in this area by the Dade County Comprehensive Development Master Plan, agricultural activity in this area is considered speculative. The Rocky Glades agricultural area includes approximately 5,320 acres. Land use statistics shown in the Modified Water Deliveries to Everglades National Park General Design Memorandum, June, 1992 indicate approximately 2,000 acres are in vegetable crop production and approximately 630 acres are in lime groves. Other tree crops in the area include mango, lychee, carambola, guava, and longon. The major vegetable crops acreage includes beans, squash and potatoes.

Average productive yields per acre for vegetable crops in Dade County are estimated to be 60 CWT for pole or snap beans, 116 CWT for squash and 200 CWT for potatoes.[2] Assuming equal quantities of the three major vegetable crops are being produced in the area and ignoring any potential multiple cropping production patterns, losses are estimated to be approximately 250,300 CWT per year. Potential production losses would be approximately 140,800 CWT per year when all trees in the area are mature. This is based upon one annual crop, an average yield of 254 boxes per acre and 88 lbs per box.[3] Information concerning direct losses to producers in the Rocky Glades area is not available at this time.

6.9 RECREATION

Hunting, fishing and birdwatching will not be adversely affected by the construction of this project. Hunting may have to be curtailed during construction for safety of the workers, but will be allowed to resume after it is completed. Waterfowl may be somewhat disturbed by construction activities. Bank fishing will continue unchanged at those accessible sites which currently exist. Use of the ramp at the lower end of C-111 near S-197 will continue unchanged. The sheet flow which will be established in the area served by these two canals will help airboaters access the

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[1] Current yield information and estimates of direct losses to producers (profit) is provided primarily by the Institute of Food and Agricultural Science (IFAS), Circular 1121, Production Cost for Selected Vegetables in Florida, 1992-1993, Scott A. Smith and Timothy G. Taylor. Other supporting information for current price per carton and price per CWT of tomato production is provided by the Florida Agricultural Statistics Service. Additional agricultural price information is provided by the United States Department of Agriculture (USDA).

[2] Yield information is provided by the Institute of Food and Agricultural Science (IFAS), Circular 1121, Production Cost for Selected Vegetables in Florida, 1992-1993. Scott A. Smith and Timothy G. Taylor. It is expected that 200 bushels of beans or 275 bushels of squash can be grown on an acre. A bushel of beans weighs approximately 30 lbs. A bushel of squash weighs approximately 42 lbs.

[3] Citrus Summary 1991-1992, Florida Agricultural Statistics Service, Orlando Florida.

pools which will be created between the plugs on these canals. Fish, wildlife and benthic populations will move into and around the spreader canal soon after work is completed.

6.10 DISPLACEMENT OF PEOPLE, BUSINESSES AND FARMS

It is anticipated that any displacement of people, businesses and farms would most likely occur only in the areas that are designated for land acquisition with the recommended plan. Two areas will be affected. These areas are the Rocky Glades agricultural area west of L-31N, located in the East Everglades Area and the Frog Pond located adjacent and east of L-31W.

The Rocky Glades area includes approximately 5,320 acres. Much of the agricultural acreage is utilized for fruit and vegetable production and little, if any existing water control exists. It can be expected that L-31N borrow canal stages between S-176 and S-331 will return to higher, design optimum levels with or without project implementation. However, the loss of groundwater storage expected with the recommended plan will reduce the flood protection west of L-31N and the C-111 canal. These combined effects will worsen conditions to agriculture in this area since no new secondary drainage is allowed in the area.

Field investigations indicate that 4 structures are located in the Rocky Glades agricultural area south of SW 168th street and north of the Frog Pond. The 8.5-square-mile residential area is located north of SW 168th street and any proposed land acquisitions are not part of the C-111 study.

To estimate the number of people displaced in this area, an estimate of people per household must be obtained. Since survey information was not available, the 1990 US Census was used. Census tract 115 includes the Rocky Glades Area, is 96% rural, and is located west of L-31N in Dade County from the Dade County - Broward County line south to State Highway 27. The average number of people per household for this census tract is 3.21. Using this information, it is anticipated that no more than 13 people would be affected by purchases in the Rocky Glades Area.

The number of affected farms has not been computed for the Rocky Glades Area. Land use statistics shown in the Modified Water Deliveries to Everglades National Park General Design Memorandum, June, 1992 are shown in Table 6-1.

No residences are located in the Frog Pond area. The area is owned by the South Dade Land Corporation which includes 6 owners. Total acreage of the area is in excess of 4,900 acres with tree islands and sloughs omitted. Of this acreage, approximately 2,800+ acres are in tomato production.

6.11 AESTHETICS

Construction for this project will have some negative impacts, but these are not expected to last for a sustained period of time. These impacts include soil disturbance, turbidity, noise, and exhaust from equipment. Access restrictions, noise and smoke associated with construction sites will interfere to an extent with enjoyment of the area and may disturb wildlife in the immediate area of the work. Once work is completed, wildlife will once again inhabit the area around the construction sites and restrictions on access will be lifted. Vegetation will quickly become established on disturbed soil areas and within a year will cover any remaining signs of the construction activity.

Table 6-1

Rocky Glades Agricultural Area
Land Use (in Acres)

Grid	Limes	Tree Crops	Vegetable Crops	Undeveloped Land	Total
7	35.9	0.00	249.20	336.81	621.91
10	0.00	23.31	15.91	493.28	532.50
13	0.00	5.35	0.00	125.97	131.32
14	0.00	0.00	304.74	308.49	613.23
16	206.30	10.30	161.65	97.01	475.26
18	105.22	34.13	267.53	85.99	492.87
19	0.00	0.00	30.54	318.93	349.47
20	63.56	0.00	358.46	180.60	602.62
21	40.19	7.15	222.98	92.87	363.19
24	1.32	1.70	9.94	123.22	136.18
25	139.57	22.52	110.03	310.04	582.16
33	40.46	40.40	276.04	65.22	422.12
Total	632.52	144.86	2,007.02	2,538.43	5,322.83

6.12 CULTURAL RESOURCES

In a letter dated January 20, 1993, the Florida State Historic Preservation Officer (SHPO) recommended that, if tree islands or oak hammocks will be affected by changes in water volumes or levels, those topographic features should be subjected to a systematic, professional archeological survey. The purpose of the survey will be to locate and assess the significance of historic properties and determine if the proposed project will adversely affect these properties.

Initially, survey will be accomplished by interpretation of aerial photographs to identify potentially habitable tree islands. Tree islands which have the potential to contain significant sites will be systematically shovel-tested to locate cultural resources. Assessment of effects to significant resources will involve determining how changes in water levels may create impacts.

If it is determined that significant historic properties will be adversely affected by the project, a mitigation plan will be developed, in consultation with the SHPO, and completed prior to construction. All work will be conducted in compliance with the National Historic Preservation Act of 1966, as amended (PL 89-655) and the Archeological and Historic Preservation Act, as amended (PL 93-291). Costs for the cultural resources survey are included in the project costs under Planning, Engineering and Design.

6.13 HAZARDOUS AND TOXIC WASTES

A preliminary evaluation of potential hazardous and toxic waste problems has concluded that potential contamination is negligible. This conclusion was based on consideration of the following;

There are few to no urbanized or modified areas that would have a potential for hazardous and toxic waste contamination. There are no landfills, industrial waste treatment plants, light industries, or other facilities likely to generate contaminants in the area of the proposed project.

Intensive agricultural practices in the area are thought to pose little or no threat due to the effects of weathering on applied insecticides or herbicides.

There is no evidence of any spill or contamination problems at any of the project structures. However, prior to purchase of lands now in agricultural production, a survey would be made of potential problem sites, e.g., chemical storage, handling areas. More intensive investigations will be completed before publication of the final integrated GRR/EIS.

6.14 AIR QUALITY

Fugitive dust from vehicular traffic and earth moving will be unavoidable but insignificant. There are no air quality issues in the study area.

6.15 UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

The following unavoidable adverse effects are expected to occur with implementation of a construction plan:

- **Wetlands** - A limited number of acres of wetlands will be lost or disrupted at the sites of levees, pumps and related structures (Table 5-5).

- **Water Quality** - Turbidity will be temporarily elevated during construction, but will return to natural levels upon project completion.

- **Agriculture** - The level of flood protection to agriculture in the area will be maintained as authorized. Should compensation be required, a settlement at full market value will be made. Agricultural lands that will be made fallow will require management to control exotic plants. The lands will have no significant wildlife value.

- **Cultural Resources** - An unknown number of historic and/or archeological sites may be affected; later studies will identify significant sites and necessary mitigation.

- **Air Quality** - Fugitive dust from vehicular traffic and earth moving will be unavoidable but insignificant.

6.16 RELATIONSHIP BETWEEN SHORT TERM USES AND LONG TERM PRODUCTIVITY

Agricultural use in the project is maintained by intensive energy investment. The project would remove this short-term use for the sake of long-term productivity in a revitalized, natural system. The comparatively short project construction period would produce several unavoidable effects, such as short, localized turbidity and disruption of habitat. In the longer term, restoration of physical form and hydrologic conditions will lead to reestablishment of the complex physical, chemical, and biological interrelationships and processes that supported the historic ecosystem's high levels of resilience, and allowed for persistence of highly diverse biological communities. As a result, most of the ecosystem will redevelop, and the restored slough and prairie systems can be expected to again support diverse populations of fish and wildlife.

6.17 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The studied flood protection project is intended to reverse recent trends in environmental degradation. Water would be restored to the area in near-historic quantities and extent of timing. The only irretrievable commitment of resources will be the expending of fossil fuels during construction and operation of the structures.

6.18 CUMULATIVE EFFECTS

6.18.1 Modified Water Deliveries to Everglades National Park

The Modified Water Deliveries to Everglades National Park Project is considered to be part of the base condition for planning purposes. That project's effects and the C-111 project effects form cumulative effects on the human environment. Analysis of hydrological data in conjunction with preparation of this report and EIS confirm that restoration of the Taylor Slough and C-111 basins is linked, both hydrologically and biologically, to restoration of the historic hydrology of the Shark River Slough area. The two areas were historically linked during wet periods when water in Shark Slough overflowed the rocky ridges into Taylor Slough, thereby influencing the latter's hydroperiod. They are linked biologically in that species with relatively large spatial requirements (snail kite, wading birds) are dependent on the combined habitat conditions of both basins for their survival. The short-hydroperiod marl prairies once served as essential early dry season foraging areas for Park-wide populations of wading birds.

The Modified Water Deliveries to Everglades National Park Project may permit a restoration of the historic link between the waters of the two project areas, to the benefit of the wide-ranging species that used both basins in historic times. During non-flood conditions, excess seepage water from Shark River Slough collected in L-31N borrow canal could be passed to the C-111 system for enhanced hydrologic restoration of Taylor Slough. Subsequent operational studies will verify and quantify the need for supplemental water in Taylor Slough. As a result, during non-flood conditions, the two projects would act synergistically: operating costs for Modified Water Deliveries to ENP Project would be reduced while the hydrologic restoration of Taylor Slough would be increased for the C-111 Project.

6.18.2 Central And Southern Florida Project Restudy

The Central and Southern Florida Project Comprehensive Review Restudy may also provide concepts that could contribute to restoration of the Everglades ecosystem from Lake Okeechobee, southward to include Florida Bay.

SECTION 7

RECOMMENDED PLAN

The recommended plan is alternative 6A. This plan, which is shown in Figure 7-1 and in detail in Appendix A, Hydrology and Hydraulic Analysis, consists of construction components, real estate requirements, construction monitoring, and operation and maintenance for the completed project.

7.1 CONSTRUCTION COMPONENTS

7.1.1 Bridge Crossings

One bridge crosses the flood plain of Taylor Slough, south of S-332 and physically located within Everglades National Park along State Road 9336. To establish historic sheet flow patterns in Taylor Slough, the existing bridge will be replaced by a longer bridge, elevated roadway, or series of culverts over Taylor Slough in order to achieve a more spatial distribution of the flow.

7.1.2 Pump Stations

Five pump stations are recommended as part of this plan. The stations are designated as S-332A, S-332B, S-332C, S-332D, and S-332E and shown in Figure 7-1. Details on the pump stations are located in Appendix D. All pumps at these stations will be powered by diesel engines so pumping capabilities will be available even during electrical power outages following major storms.

7.1.2.1 S-332A

Pump station S-332A is one of four new 300 cfs capacity structures that would pump water from L-31N borrow canal westward toward Everglades National Park. S-332A would be located near the junction of C-102 and the L-31N borrow canal. The pump station will discharge into a concrete lined canal extending west toward the ENP. S-332A will have a total capacity of 300 cfs using four 75 cfs pumps driven by diesel engines.

7.1.2.2 S-332B

Pump station S-332B is one of four new 300 cfs capacity structures that would pump water from L-31N borrow canal westward toward Everglades National Park. S-332B would be located midway between C-103 and C-102 along the L-31N borrow canal. The pump station will discharge into a concrete lined canal extending west toward the ENP. S-332B will have a total capacity of 300 cfs using four 75 cfs pumps driven by diesel engines.

7.1.2.3 S-332C

Pump station S-332C is one of four new 300 cfs capacity structures that would pump water from L-31N borrow canal westward toward Everglades National Park. S-332C would be located near the junction of C-103 and the L-31N borrow canal. The pump station will discharge into a concrete lined canal extending west toward the ENP. S-332C will have a total capacity of 300 cfs using four 75 cfs pumps driven by diesel engines.

7.1.2.4 S-332D

Pump station S-332D is one of four new 300 cfs capacity structures that would pump water from L-31N borrow canal westward toward Everglades National Park. S-332D pump station would be placed in the L-31W borrow canal, west of S-174, and would pump water through a concrete lined canal connected to the outlet side of S-332D and discharge 0.5 mile west through the new S-332D Tieback levee into the new retention/detention zone. S-332D will have a total capacity of 300 cfs using four 75 cfs pumps driven by diesel engines.

7.1.2.5 S-332E

This pump station is located at the junction of the C-111 and C-111E canals. It has a 50 cfs capacity and will discharge into a spreader canal, C-111N, which will promote sheet flow south towards the panhandle of Everglades National Park. The pump is designed to be driven by a diesel engine.

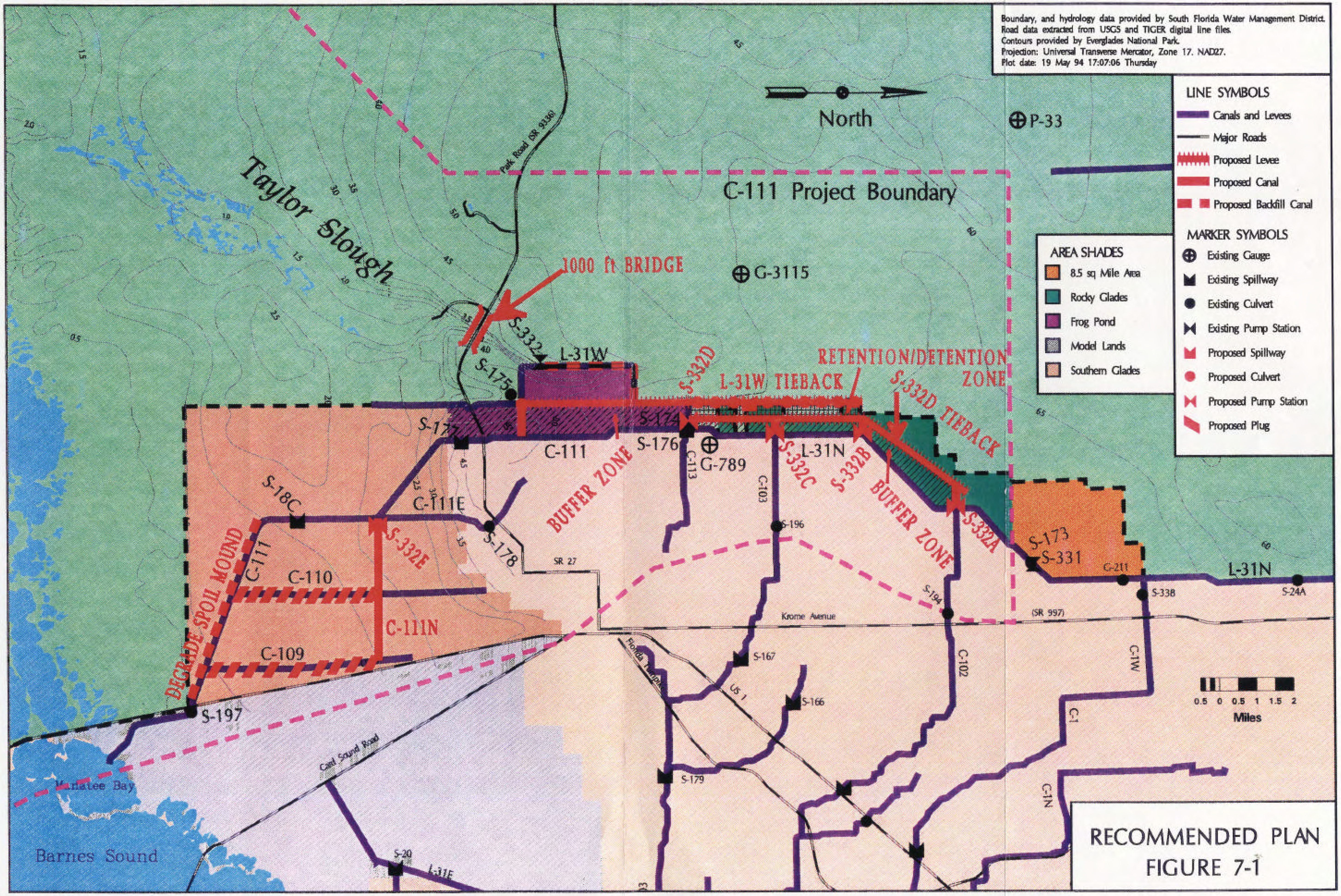
7.1.2.6 S-332

Existing pump station S-332 would remain, with necessary appurtenances designed for the original 165 cfs capacity structure. This pump station would draw water from C-111, through an extension of the L-31W borrow canal.

7.1.3 Levees and Canals

7.1.3.1 Levee 31W Tieback

This new north-south levee would be constructed roughly parallel to existing L-31N beginning at L-31W near S-175 and extending northward approximately 9.25 miles to higher ground in the Rocky Glades area in the vicinity of S-332B to form the retention/detention area. The levee would be constructed with material obtained



RECOMMENDED PLAN
FIGURE 7-1

from the degrading of the C-111 disposal mounds along the southern portion of the project. The levee crown width would be 15 feet with 1 vertical on 3 horizontal side slopes. Twenty-four 36-inch diameter CMP culverts with stoplog risers would be placed in the levee at approximate half-mile intervals. An emergency spillway would also be constructed in the tieback to prevent overtopping of the levee. The spillway would be 300 feet in length and bank protection would be provided along the downstream face.

7.1.3.2 S-332D Tieback

An additional new north-south levee would be created that would run parallel to L-31N, designated S-332D Tieback. It would be located about one-half mile west of L-31N, bisecting the lands between the existing L-31N and the proposed L-31W Tieback. The northern terminus of S-332D Tieback would tie into high ground in the Rocky Glades area. A southern segment of the levee would turn eastward and run parallel to L-31W about one-half mile west of L-31N, and tie into a new pump station that would be located immediately west of S-174. The levee top would be about three to four feet above existing ground elevations. Borrow material for this levee would come from either the existing disposal mounds along C-111, or an adjacent borrow canal. This borrow canal would not be continuous, and it would not carry flow.

7.1.3.3 Levee 31W Borrow Canal

The borrow canal along the portion of the existing L-31W between S-332 and the alinement for the new L-31W Tieback Levee would be filled by degrading the adjacent levee.

7.1.3.4 Discharge (Getaway) Canals at S-332A, S-332B and S-332C

Pump Stations S-332A, S-332B and S-332C will lift water from L-31N and direct it westward through 0.5 mile long concrete lined discharge canals to the retention/detention zone just west of the new levee, L-31W Tieback. Concrete lined canals would be provided to minimize return seepage to L-31N. Materials from canal excavation would be placed along both sides of each canal and graded to create berms of sufficient elevation and width to satisfy the hydraulic design requirements and to provide access for maintenance.

7.1.3.5 Discharge (Getaway) Canal at S-332D

Pump station S-332D would be placed immediately downstream of S-174, and discharge water into the existing L-31W Borrow Canal. This canal would be concrete lined and extend westerly from L-31N Borrow Canal for about one-half mile.

7.1.3.6 Pump Station S-332 Connector Canal

Existing pump station S-332 would remain in service. A connector canal from C-111 would provide water to the west (to S-332) and south (to S-175). The L-31W levee would be realigned as shown in Figure A-5. The excavated material would be sidecast along one side of the canal and graded to provide access for maintenance.

7.1.3.7 Eastern Spreader Canal (C-111N)

A canal would be constructed from the intersection of C-111 and C-111E and extend eastward toward US Highway 1. The excavated material would be sidecast along the north side of the canal and graded to form a continuous berm. The berm would provide maintenance access and help initiate sheetflow southward toward the panhandle of Everglades National Park. In addition, impacts on the state correctional institute property would be minimized.

7.1.3.8 Canal 109 and Canal 110 Plugs

Nine plugs would be constructed in C-109 and ten plugs would be constructed in C-110 to help promote sheet flow from north to south between these canals. Material for construction of the plugs would be obtained from the adjacent disposal mounds.

7.2 REAL ESTATE

7.2.1 Lands and Easements

Lands needed for the restoration of Taylor Slough will be acquired in fee to ensure that they will continue to be available solely for that purpose over the life of the project. This will require acquisition of the lands known as the Rocky Glades as well as the Frog Pond as shown in Figure 1-4 in Section 1. The retention/detention area is needed for storage and flow dispersion. The buffer zone may have some surface ponding near the detention area and will have higher groundwater levels than under pre-project conditions, thus increasing its susceptibility to flooding. This land will be used as a buffer zone between the agricultural community and the environmental community. The SFWMD already owns the lands to be affected by C-111N spreader canal. Acquisition of 11,866 acres are necessary for this plan. Of this, 1,078 acres have been acquired by the ENP for their 1989 expansion. The acquisition of land interests in the retention/detention area reflects damages from higher water levels.

All construction work areas, disposal areas and borrow areas for the lower C-111 Project are located within the proposed right-of-way limits. However, estates are provided in the event additional areas are required.

Appendix C contains a detailed Real Estate Plan.

7.2.2 Relocation Assistance (Public Law 91-646)

Based on information received from South Florida Water Management District, there are approximately 4 residences within the project area that will be affected by this project and will require relocation payments as specified under the provisions of Title II of Public Law 91-646.

Estimates of costs to comply with Public Law 91-646 total $90,000. This estimate represents a payment of $22,500 for each of the 4 owner-occupied residential relocations which includes expenses incurred for recording fees, transfer taxes and costs of prepayment for pre-existing mortgages incident to conveying real property to the local sponsor and the estimated costs with providing displaced persons with comparable decent, safe and sanitary replacement housing.

A preliminary survey of the area indicates that there appears to be sufficient decent, safe and sanitary replacement housing available for persons affected under the project.

7.2.3 Construction Relocations

7.2.3.1 Public Highways and Bridges

One bridge crosses the floodplain of Taylor Slough, south of S-332 and physically located within Everglades National Park along State Road 9336. Increased water from the alternative requires the bridge over Taylor Slough to be expanded. State Road 9336 will be permanently relocated adjacent to the existing road. The land needed for the new bridge is Federally owned and is not valued but has been included in the total project acreage.

7.2.3.2 Utilities Relocations

There are no known utilities affected by the project.

7.2.3.3 Relocations of Towns and Cemeteries

There are no known towns or cemeteries located within the project area.

7.3 MONITORING

Monitoring of indicators of environmental quality has begun. Under joint agreement between the U.S. Army Corps of Engineers, Everglades National Park, the South Florida Water Management District, and the U.S. Fish and Wildlife Service, in cooperation with the Florida Game and Fresh Water Fish Commission, ENP personnel and contractors are conducting studies and developing monitoring criteria. The study plan will be refined during detailed design phase to produce a detailed ecological monitoring plan. Annex H contains an outline of the environmental monitoring plan.

Construction activities will be monitored to ensure prevention of environmental damage. The effectiveness of silt and sediment barriers, both in the water and on land, in preventing fugitive, water-borne material from covering valued resources would be checked and measured. All construction activities would be inspected for conformance to environmental protection specifications.

The Corps, ENP, SFWMD, and USFWS will continue monitoring cooperatively through the construction stage. It is expected that after construction appropriate monitoring will carried on by ENP and the SFWMD.

7.4 OPERATION, MAINTENANCE, AND MANAGEMENT

7.4.1 Water Management

Water Control and Operations and Maintenance Manuals will be prepared and provided to the non-Federal sponsor prior to final turnover of the project. During construction, interim water control plans will be prepared to ensure that project objectives are safely accomplished.

7.4.2 Land Management

Land management practices for the lands acquired for restoration shall be consistent with project purposes. As previously discussed, restoration will occur by allowing the system to return to as near a natural state, as hydrologically possible. However, some land management practices, including prescribed burning and fencing and posting to prevent trespassing, will be necessary. SFWMD will be responsible for managing lands within the buffer zone. This will require control and prevention of exotic plant invasions.

7.4.3 Structures

The structures of the completed project include the 5 pump stations, S-332A, S-332B, S-332C, S-332D and S-332E, and culverts on the connecting canals to the pumps. These structures will be operated in accordance with the operation manuals described above. The maintenance of these structures include activities such as periodic maintenance of mechanical equipment; sand blasting and painting gates; ensuring levees are grassed and mowed to prevent erosion and settling; periodic maintenance of electrical equipment; and ensuring inlet and outlet channels are clear of snags.

7.5 PROJECT IMPLEMENTATION

7.5.1 Project Management Plan

A Project Management Plan (PMP) has been prepared for the recommended plan. It identifies specific tasks to be accomplished during preconstruction engineering and design (PED) and specific contracts and construction management activities for construction.

7.5.2 Detailed Design

During the PED phase, three technical Feature Design Memorandums (FDMs) and a Real Estate Design Memorandum (DM) will be produced. Final designs will be developed for all project features as needed to meet the objectives of the C-111 project. Refinements in project features as to their exact location and design details will be made based on these detailed design analyses. FDM 1 will address project features such as the bridge (elevated roadway) across Taylor Slough and removal of spoil mounds along lower C-111 which can be fully designed based on existing hydraulic modeling. The United States Geological Survey (USGS), under contract to the Corps of Engineers, is now developing an advanced hydraulic model of the C-111 Basin for detailed analysis of surface and groundwater conditions. In FDM 2, this advanced hydraulic model will be used to determine the final hydraulic design requirements for the remaining project features. This advanced hydraulic model will also be used to evaluate in more detail the curtain wall proposal received during public comments on the C-111 GRR. Study results from FDM 2 will be the technical basis for preparation of the Real Estate DM and preparation of FDM 3 which will present the detailed technical design of remaining project features. Plans and specifications will be prepared for 4 construction contracts covering work items as detailed below.

7.5.3 Construction Sequence

Construction of C-111 is expected to be divided into 4 contracts. This will expedite construction of project features to be built on existing public lands and thus expedite hydrologic improvements in Everglades National Park. Construction will be initiated in FY 96. The availability of real estate is expected to control the construction sequence and schedule. Because of the anticipated lengthy real estate acquisition period, construction is expected to continue over about a five year period as shown in the PMP.

The first contract will be for construction of a bridge (elevated roadway) across Taylor Slough in Everglades National Park, removal of the existing roadfill which interrupts the natural sheetflow of water in this area, removal of spoil mounds along lower C-111 and plugs in canals C-109 and C-110. Contract 2 will be for construction of pump station S-332E and associated spreader canal C-111N. Land acquisition is not required for Contracts 1 and 2.

Project works in the Frog Pond area will be performed under Contract 3. Most of the lands in this area are held by a few owners so land acquisition is expected to be faster than for the Rocky Glades area where there are approximately 300 owners. Work items to be completed under Contract 3 include portions of Levee L-31W Tieback, connector canal from existing S-175 to C-111, backfill L-31W borrow canal north of existing S-332 and construction of pump station S-332D.

Contract 4, for construction of project works in the Rocky Glades area, will complete the recommended works. Pump stations S-332A, B and C, associated concrete lined discharge channels, the remainder of L-31W Tieback and levee S-332D Tieback will be constructed under Contract 4.

7.5.4 Environmental Protection During Construction

Corps construction contract specifications include environmental protection requirements. These requirements cover prevention of environmental pollution and damage as a result of construction operations under the contract. Environmental pollution and damage are defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic, cultural and/or historical purposes. The control of environmental pollution and damage requires consideration of air, water, and land, and includes management of visual aesthetics, noise, solid waste, radiant energy and radioactive materials, as well as other pollutants. Staging, storage and vehicle routes and parking areas are subject to advanced planning and approval by the Corps and local sponsor. The transportation and storage of petroleum products for use during construction is regulated by existing laws and by Corps regulations and practice.

Within 20 calendar days after the date of the notice of award of a contract, the construction contractor is required to submit an environmental protection plan. The contractor cannot proceed with construction until the plan is approved. The environmental protection plan includes the following:

* A list of Federal, State and local laws, regulations, and permit requirements concerning environmental protection and pollution control and abatement that are applicable to the contractor's proposed operations, and the requirements imposed by those laws, regulations, and permits.

* Methods for protection of features to be preserved within authorized work areas. The contractor shall prepare a listing of methods to protect resources needing

protection, including: trees, shrubs, vines, grasses and ground cover, landscape features, air and water quality, fish and wildlife, soil, and historical, archeological and cultural resources.

* Procedures to be implemented to provide the required environmental protection and to comply with the applicable laws and regulations. The contractor shall provide written assurance that immediate corrective action will be taken to correct pollution of the environment due to accident, natural causes or failure to follow the procedures set out in accordance with the environmental protection plan.

* Permit or license and the location of the solid waste disposal area.

* Drawings showing locations of any proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of materials.

* Environmental monitoring plans for the job site, including land, water, air and noise monitoring.

* Methods of protecting surface and ground water during construction activities. Special measures shall be specifically addressed and shall include reduction of turbidity and aeration of discharge prior to waters being released into the canal.

* Oil and fuel spill contingency plan.

* Work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or non-use. The plan would include measures for marking the limits of use areas.

* Plan for any dewatering activities associated with borrow areas.

The above minimum environmental protection procedures are expected to completely prevent avoidable environmental damage during construction. Typical spill contingency plans and measures are intended to contain, absorb and remove pollutants from the ecosystem for disposal in previously identified approved disposal areas.

7.6 COST ESTIMATE

7.6.1 Initial Costs

The total estimated cost of the recommended plan is approximately $121,400,000, at May 1993 price levels. A Micro-Computer Aided Cost Estimating System (M-CACES) estimate is shown in Appendix D. A project cost estimate by feature is shown in Table 7-1.

Table 7-1
Project Cost Estimate

Feature Account	Project Cost
01 - Lands and Damages	$50,700,000
09 - Channels and Canals	$25,400,000
11 - Levees and Floodwalls	$2,200,000
13 - Pumping Plants	$20,700,000
15 - Floodway Control - Diversion Structure	$4,900,000
30 - Planning, Engineering, Design, Cultural Resources, and Monitoring	$12,200,000
31 - Construction Management (S&I)	$5,300,000
TOTAL	$121,400,000

7.6.2 Investment Costs

The computation of interest during construction (IDC) is based on scheduled construction expenditures. Calculation of IDC assumes equal construction expenditures in each month over the 5 year construction period. It is assumed that environmental benefits will be realized during the construction period, specifically after individual project features are completed. However, flood control benefits will not be realized until the entire project is completed. At 8 percent the IDC for the selected plan is $15,534,000.

7.6.3 Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) Costs

Annual operation and maintenance costs were estimated for the components of the selected plan. Replacement costs at twenty-five years were calculated for the mechanical equipment contained in the culverts and pump stations. The OMRR&R costs are provided in Table 7-2.

Table 7-2
Annual Operation, Maintenance, Repair, Replacement, and Rehabilitation Costs

Component	Average Annual Cost
Pump Stations Operating Costs: S-332A, S-332B, S-332C, S-332D, S-332E	$549,100
Pump Replacements	$39,900
Flap Gates	$7,900
Culvert Risers	$48,300
Canals	$900
Levees	$20,800
Land Management	$178,000
Total Annual OMRR&R	$844,900

7.6.4 Annual Costs

Investment costs were converted to annual costs using an interest rate of 8 percent and a project life of 50 years to compute interest and amortization. Annual operation and maintenance costs were then added to the interest and amortization costs to determine the average annual cost, which is $12,039,000 for the selected plan.

7.7 COST SHARING

7.7.1 Authority

Responsibilities for implementing the Recommended Plan will be shared by the Corps of Engineers, on behalf of the Federal government, and the local sponsor. The Corps will design the project and administer construction contracts to build the project. The local sponsor will be involved in the project design and will share a portion of design and construction costs; furnish necessary lands, easements, rights of way, relocation, and disposal sites (collectively referred to as LERRD); and operate and maintain the completed project.

The authority to construct and to cost-share the C-111 project is the Flood Control Act of 1968. In 1968, the ENP-South Dade Conveyance Canals were authorized (PL 90-483). A major purpose of this system was for conservation and conveyance of water supplies to the eastern portion of the ENP and to the expanding agricultural and urban areas of south Dade County. The policy established in 1968 required the non-Federal sponsor contribute in cash 20 percent of the sum of the construction cost plus the costs of supervision and administration and provides all lands, easements, and right-of-way including suitable disposal areas determined by the Corps of Engineers, necessary for construction and maintenance of the project, and accomplish all relocations and alterations of structures, utilities, highways, and bridges and related and special facilities determined to be necessary for construction of the project.

Improvement of water quality is currently a non-Federal cost. If water quality treatment areas are warranted for the area, the cost will be a non-Federal cost.

The operation and maintenance cost of the project are a local responsibility, however, the Flood Control Act of 1968 specified the annual pumping costs, including fuel, lubricants, proportional depreciation and repairs, and operating labor for the pump stations are cost shared 60 percent Federal and 40 percent non-Federal.

The Department of Interior (DOI) legislation (P.L. 103-219) to amend the Everglades National Park Protection and Expansion Act of 1989 (P.L. 101-229), authorized the funding to acquire and cost share the lands in the Rocky Glades and Frog Pond through a 25 percent Federal (DOI) contribution.

An evaluation was made as to whether raising the Park road (SR 9336) was a relocations cost or a construction cost. Flow through the constriction of the road needs to pass at least 1000 cfs due to the new plan. This flow distribution system will involve either culverts or a bridge to spread the water over a wider range in Taylor Slough. The cost of passing additional water is a construction cost and not a relocations cost.

7.7.2 Federal and Non-Federal Shares

Cost sharing for the project is shown in Table 7-3. The Federal (USACE) share is $59,027,000. The non-Federal share is $62,386,000.

Table 7-3
Cost Apportionment for Recommended Plan

ITEM	TOTAL $	FEDERAL $ (USACE)	SPONSOR $
Construction (including channel, levee, Construction Mgmt, elevation of Park Road)	58,481,000	46,785,000 (80 %)	11,696,000 (20 %)
PED	12,242,000	12,242,000	0
Real Estate (including acquisition/admin costs)	50,690,000,	0	50,690,000 (100%) *
Subtotal	121,413,000	59,027,000	62,386,000

* Legislation (P.L. 103-219) signed on March 9, 1994 authorizes the Department of Interior to contribute 25 percent of the purchase price of these lands.

The Federal and non-Federal share of the operation, maintenance, repair, replacement and rehabilitation costs are shown in Table 7-4.

Table 7-4
Operation, Maintenance, Repair, Replacement and Rehabilitation Costs

ITEM	TOTAL $	FEDERAL $	SPONSOR $
WATER SUPPLY TO ENP	589,000	353,400 (60 %)	235,600 (40 %)
O&M REMAINING PROJECT	255,900	0	255,900 (100 %)
TOTAL	844,900	353,400 (42 %)	491,500 (58 %)

7.8 FINANCIAL ANALYSIS

It is expected that the SFWMD will have the capability to provide the required local cooperation for the Recommended Plan. A financial analysis will be conducted to assess the SFWMD's capability to financially participate in the Recommended Plan prior to signing of the PCA.

7.9 LOCAL COOPERATION

The project's non-Federal sponsor must provide its share of project costs, including LERRD and cash for construction and later OMRR&R costs, as described above. LERRD are to be furnished to the Federal government prior to the advertisement of any construction contract which involves those LERRD. In providing LERRD, the sponsor must comply with the provisions of the Uniform Relocations Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646), as amended. Any required cash payments for project construction costs are to be made during construction to allow expenditure at a rate proportional to Federal expenditures. The sponsor's share of preconstruction engineering and design costs will be repaid during the first year of construction. The sponsor is also required to pay all costs associated with locally preferred features of the Recommended Plan, such as the potential water quality treatment areas.

A project may be initiated only after the sponsor has entered into a binding project cooperation agreement (PCA) with the Department of the Army, which is normally negotiated during the preconstruction engineering and design phase. The PCA assigns Federal and non-Federal responsibilities, which, for this C-111 project, will include the following items of local cooperation as required in the 1968 Flood Control Act and modified by Executive Order:

a. Make a cash contribution of 20 percent of the contract price plus supervision and administration for all items of work to be provided by the Corps of Engineers, an amount presently estimated at $11,696,000 to be paid in a lump sum prior to start of construction or in installments prior to start of pertinent work items in accordance with construction schedules as required by the Chief of Engineers, the final allocation of costs to be make after the actual costs have been determined;

b. With appropriate jurisdiction, construct and thereafter maintain such canal facilities and other water control appurtenances as are necessary to realize the benefits from the improvements;

c. Provide without cost to the United States all lands, easements, and right-of way necessary for construction, operation and maintenance of the project, when and as required;

d. Assume the cost of construction of all non-Federal highway bridges, relocation of existing non-Federal highway bridges and alteration of utilities and other improvements except railroads, incident to construction of the project.

e. Hold and save the United States free from damages due to the construction, operation, and maintenance of the project works;

f. Participate in the National Flood Insurance Program and other applicable Federal flood plain management programs;

g. Provide guidance and leadership to prevent unwise future development in the flood plain;

h. Assume financial responsibility for all costs incurred in cleanup of hazardous materials located on project lands covered under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), for which no cost sharing credit shall be given, and operate, maintain, repair, replace, and rehabilitate the project in a manner so that liability will not arise under CERCLA;

i. Operate and maintain the pumping stations, levees, canals, and other appurtenant works herein, after completion of construction for flood control, navigation, and backpumping and delivery of water to Everglades National Park, the agricultural areas, and urban areas, in accordance with regulations approved by the Secretary of the Army. The Federal government, however, would reimburse local interests 60 percent of the annual pumping costs, including fuel, lubricants, proportional depreciation and repairs, and operating labor for all pump stations. All other operation and maintenance costs of the project will be borne by local interests.

7.10 INTEGRATION WITH MODIFIED WATER DELIVERIES TO ENP PROJECT

Operating studies are being performed for the Modified Water Deliveries to ENP Project to identify the optimum operating strategy to benefit hydrologic restoration of Shark River Slough. The physical water management system boundary between this project and the C-111 project features is S-331.

The structural features of the Modified Water Deliveries to ENP Project are designed so that during flood conditions, all excess water that reaches the L-31N borrow canal north of S-331 is returned northward to Northeast Shark River Slough via a new pump station, S-356. This avoids the potential for exacerbating concurrent flood problems in the C-111 basin to the south.

The recommended structural plan presented herein is not designed to discharge additional flood waters from upstream of S-331. Therefore, the structural modifications recommended for the Modified Water Deliveries to ENP Project will still be required to keep these drainage basins separate during a storm event.

During normal (non-flood) periods, however, there is great potential for the structural features of both projects to be operated for mutual benefits. A portion of the water to be returned to Northeast Shark River Slough via S-356 as a part of the Modified Water Deliveries to ENP Project could be discharged southward under some conditions. The average annual discharge at S-356 will be about 72,000 acre-feet (U.S.

Army Corps of Engineers 1992). This includes seepage water from Northeast Shark River Slough into the L-31N borrow canal that will occur under non-flood conditions. A substantial portion of this water would likely be available for supplemental flows to the C-111 basin. Such discharges could be made only when there would be no potential increase in flood risk in the C-111 basin.

Operating studies will be combined for both projects, Modified Water Deliveries to ENP and C-111. In this way, benefits derived from the C-111 project could be enhanced by an additional source of potentially substantial volumes of water from upstream. Diverting such discharges southward through gravity flow would benefit the Modified Water Deliveries Project by reducing operating costs associated with pumping at S-356. Operating studies will include an evaluation of the need for, and availability of supplemental water supplies for the C-111 basin.

If the 8.5-square-mile area is acquired as a result of the pending legislation, the seepage levee, seepage collection canal, and pump station currently proposed in the recommended plan for Modified Water Deliveries to ENP would not be constructed. The project would still function as designed. No significant changes in the C-111 recommended plan would be necessary.

7.11 SPONSOR VIEWS

As the non-Federal sponsor of this project, the South Florida Water Management District (SFWMD) has worked very closely in partnership with the Corps to ensure that the study and this report fairly and accurately reflected their views.

SECTION 8

PUBLIC INVOLVEMENT, REVIEW AND CONSULTATION

8.1 PUBLIC INVOLVEMENT

Public involvement in the planning process is continuing. Responses to information about this GRR-EIS have included correspondence (Annex A) and requests for meetings with individual agencies and groups. New alternatives are being advanced by several parties, and these will be considered prior to publication of a final report.

8.2 REPORT RECIPIENTS

A list of recipients of the draft report is in Annex H.

8.3 CONTINUING COORDINATION

Coordination continues with publication of the final GRR-EIS. The expedited schedule in concert with unexpected delays in development of needed information has delayed completion of the Fish and Wildlife Coordination Act Report. The Fish and Wildlife Coordination Act report consists of a letter dated January 19, 1994, from the U.S. Fish and Wildlife Service. The letter contains reference to the USFWS expectation of a more detailed report to be submitted in the Spring of 1994. The anticipated report was not completed, and by telephone communication, Mr. David Ferrell, Chief, USFWS Vero Beach Field Office, assured that his office continues to support the planning process. Lack of an operational plan prevents preparation of a fully responsible FWCA Report. The Corps agrees, and defers to the Department of the Interior's letter of comment, submitted in accordance with the Act.

Concerned and affected parties may continue to contact the U.S. Army Corps of Engineers at the address and telephone number listed on the cover sheet.

8.4 SCOPING

Scoping was initiated by letter to all known interests, including Federal, State and regional agencies, Native American tribes and groups, and organized citizen groups. The latter included agricultural interests, sporting interests, and conservation interests. Additionally, individuals known to interested in or affected by the studied work were contacted and kept informed.

Scoping continued throughout the planning phase with several meetings involving representatives of the Park, USFWS, Florida Game and Fresh Water Fish

Commission, the South Florida Water Management District, and Audubon Society. As a team effort alternative measures and plans were developed and the final array of feasible alternatives selected for evaluation.

Letters in response to scoping activities were received from:

National Audubon Society
National Marine Fisheries Service, SE Regional Office
Dade County, Florida Environmental Resources Management
Everglades National Park
U.S. Fish and Wildlife Service

Correspondents recommended that water quality problems be addressed and corrected in the study area. Selection of a preferred alternative by December, 1993, was urged. The preferred alternative should be flexible, so that a suitable operation for water supply to restore Everglades ecosystem may be possible. Replication of southern Everglades hydroperiod and all other ecologically important conditions, on a smaller geographic scale, was urged as a final goal. Monitoring during design and after construction to ascertain effects on biota and hydrology was recommended.

Water quality considerations are addressed in Section 2. Planning efforts have been directed toward optimal levels of hydrological and ecological restoration, the immediate goal being to identify an alternative structural plan that will provide most flexibility for re-establishing historic hydroperiods that supported the historic flora and fauna. Monitoring tasks are to be determined during design stage.

8.5 COMMENTS AND RESPONSES ON THE PRELIMINARY DRAFT INTEGRATED GENERAL REEVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

A preliminary draft version of this report was distributed for public review on December 23, 1993. Written comments on the report were received from the following:

Metropolitan Dade County
Florida Department of Environmental Protection
Florida Game and Fresh Water Fish Commission
Florida Division of Historical Resources
South Florida Regional Planning Council
Friends of Conservation
Ghioto and Associates
Hydrologic Associates U.S.A., Inc.
Florida Department of Transportation
National Audubon Society
Law Offices of John L. Polk, P.A.

Mr. Barney W. Rutzke
Institute of Food and Agricultural Sciences, University of Florida
U.S. Fish and Wildlife Service
U.S. Soil Conservation Service
Everglades National Park
Miami-Dade Water and Sewer Authority Department
Tropical Audubon Society, Inc.
State of Florida, Office of the Governor

The following discussion summarizes comments received during the preliminary review and provides responses and/or describes how the comments were addressed in this report.

8.5.1 Plan Formulation Comments/Responses

a. Scope of Project

Page 5 of the preliminary draft report was in error. The study basin's northern boundary is a line drawn east from S-331, the divide control structure, and west on the southern limit of the eight and one half square mile area. The map in Figure 1-2 correctly displays the study area.

The scope of the Federal Project is to restore more natural hydrologic conditions in the C-111 basin, including Taylor Slough while maintaining flood control capability. The Model Lands area (land between U.S. Highway 1 and Card Sound Road) are not within the study area.

b. Culvert under Highway 1

The single culvert in Alternative 4 will pass approximately 100 cfs from the east-west spreader canal to the extension east of U.S. Highway 1. A battery of smaller culverts will impede flow in the canal towards the lands east of U.S. Highway 1. It is assumed that the culvert under the highway will be constructed by Department of Transportation as a part of the construction of widening the highway. The culvert is not included as a C-111 project cost.

c. Water Quality

All measures will be taken during construction to minimize turbidity from existing surface waters.

d. S-197 Operation

A discussion was added to the revised draft report (see section 2.2.3), describing the operational plan is not to open S-197 unless absolutely necessary. Flows will be discharged at S-18C and will overflow the southern bank of C-111 into ENP. Construction of 10 additional culverts at S-197 by SFWMD has provided much greater operational flexibility. All alternative plans considered would reduce the potential need for sustained discharges through S-197 into Manatee Bay/Barnes Sound.

e. Proposed Alternative

In response to comments received from various agencies on the preliminary draft report, Alternative 6 has been modified to become 6A. This plan incorporates the same water detention/retention area as described in a proposed alternative to address the water quality concerns and the need to disperse flows across a broader spatial extent in the Taylor Slough headwaters. There is also a buffer zone to provide a transition between the Everglades National Park and the agricultural community on the east. The proposed plan is described in section 5.6.4.11.

f. New Plans

DEP's modified alternative 4 is very similar the Park's Concept 8. Alternative 6A was derived to address the same goals as these plans. Maintaining the lower section of C-111 will provide operational flexibility for discharge of excess flood waters or to provide supplemental discharges to northeast Florida Bay by keeping S-197 closed and allowing overflow from the canal. DEP's proposed plan calls for water to pass from C-111 to the surge reservoir and back to C-111. This water will not be sent to Taylor Slough which is one of the Federal objectives. Additionally, by attempting to store water immediately adjacent to L-31N, the seepage into the canal will be increased. This will require greater pump capacity and more frequent operation. By moving the detention/retention area to the west of L-31N as in alternative 6A, the hydraulic gradient towards the canal will flattened and seepage will be reduced.

The agricultural community has proposed a plan which would surround the agricultural areas with a curtain wall. This plan was evaluated as alternative 9 and is described in section 5.6.4.10. This curtain wall would have to extend through the Biscayne aquifer to a distance of about 60 feet. The purpose of this proposal was to create a barrier between ENP and the farm land, without taking the farmland out of production. Seepage losses from ENP towards L-31N would be reduced considerably. Several plans were developed, including metal and plastic sheetpile and a slurry trench. The most cost-effective method was a Gundwall plastic sheetpile with hydrotite, which cost approximately $6,623,000 per mile. Using lands developed under plan 6, the cost of the sheetpile wall was approximately $102,000,000 versus the cost of purchasing these lands at $50,690,000.

g. Hole-in-the-Donut Restoration

The ENP has filed for a dredge and fill permit for restoration of the Hole in the Donut lands. The disposal area identified for this project is the eastern half of the Frog Pond, approximately 3,083 acres. ENP has obtained approval of this plan from the owners of the Frog Pond, the South Dade Land Corp. Early estimates for completion of the project are 15 years.

h. Lower Canal Stages

This alternative, proposed by agricultural interests, is in contradiction of the objectives of the study to provide the operational flexibility to maintain higher water levels along the boundary of the headwaters and upper portions of Taylor Slough. Bringing current canal stages up to the authorized levels and pumping water to the west will begin to restore historic hydroperiods in Taylor Slough, an objective of the study.

i. Lining L-31W

The lower portion of the L-31W borrow canal lies within the drainage area of upper and middle Taylor Slough. This proposal by agricultural interests suggests that lining the L-31W borrow canal would minimize the drainage of Taylor Slough while allowing canal stages needed to provide flood protection to adjacent agricultural lands. The minimal seepage cutoff provided by lining the canal would be ineffective given the depth and very high permeability of the surficial aquifer in the study area.

j. Water Supply Preserves

The water supply preserves suggested by the National Audubon Society are outside the scope of the C-111 basin. Alternative 6A addresses their issues on a smaller scale, including water retention/detention, buffer zone, spatial distribution of water and water quality. Furthermore, if the water supply preserve plan is later adopted for implementation, the plan recommended in this report would be consistent with this concept and could be incorporated into a more comprehensive regional plan.

k. Scope

To rehydrate lands east of U.S. Highway 1 is outside the scope of this project. These lands are not part of water supply to Everglades National Park. Ideas developed outside the scope of the project can be addressed as locally preferred features of the selected plan at a 100 percent non-Federal cost. The Federal project is shown in Alternative 6A.

l. Backfill C-111

Preliminary data developed at the SFWMD showed that the backfilling of C-111 caused a reduction in water moved to the land south of the lower section of C-111. This in turn was detrimental to the ecological balance in lower C-111. It is unknown at this time if operational studies can rectify this situation, but the Corps will continue to investigate this possibility during the design phase. In 1990, the SFWMD replaced the plug in lower C-111 with 10 culverts. This action will greatly will greatly reduce the likelihood of major damaging discharges to Manatee Bay/Barnes Sound. All of the culverts have been opened once since their construction and no significant effect has been measure. Since groundwater flow is in a southeast direction, the flow of water in the lands north of C-111 will flow to the southeast and away from ENP, and not to the western portion of the eastern panhandle of ENP. In the operational phase, S-197 will be closed and water will gravity flow south across the ENP into Florida Bay.

m. Full Restoration

None of the plans modeled will achieve full restoration. The intent of this study was to analyze the best way of achieving the objectives by providing structural capability to control the location, timing, and quantity of discharges with available water. During the design phase of the study, and subsequent studies like the C&SF Comprehensive Review Study and Modified Water Deliveries to ENP, plans to bring more water to the C-111 basin will be developed, which will work towards restoration of the C-111 basin.

n. Operational Studies

Sections 5.4 was added to describe operational criteria used to evaluate all alternative plans. An important objective of this project is to provide a structural system that is adequate to provide the operational flexibility to restore more natural hydrologic conditions in Taylor Slough. Operational studies to identify an optimal operating plan will require additional data collection and evaluation. In order to expedite the resolution of environmental problems in the park, design and construction of the desired structural features will proceed while the operating plan is being defined. As described in a new section 7.9, the operating plan for Modified Water Deliveries Project will be coordinated with the C-111 operating studies.

o. Federal Objective

Both negative and positive impacts have been addressed in the report.

p. Flood Control

There are measurable flood damage reduction benefits for each plan.

q. 8.5-square-mile area

A more detailed description of the entire Modified Water Deliveries to ENP Project has been provided in the "Future Without Project Condition" section. Additionally, information has been added in a new section "Integration of the Recommended Plan with the Modified Water Deliveries to ENP Project." The recommended plan calls for construction of a levee, seepage collection canal, and a pump station, S-357, to prevent adverse impacts to the 8.5-square-mile area as a result of restoration of Shark River Slough. Legislation has been enacted authorizing the Department of Interior to utilize previously appropriated funds to contribute up to 25 percent of the cost of acquiring the 8.5-square-mile area, the Rocky Glades agricultural area, and the Frog Pond. The acquisition would be a cooperative effort by SFWMD, DOI, the State of Florida, and Dade County. If the land is acquired, there would be no adverse impact on the recommended plan.

r. S-331 operation for recommended plan

S-331 will be operated as it is designed with implementation of the recommended plan. It will be used for water supply deliveries to the ENP-South Dade County Conveyance Canal system when water levels drop 1.5 feet below their optimum levels in the downstream reaches. The pump will not continue to be used to prevent flood impacts in the 8.5-square-mile area.

s. Project purpose for acquisition of the Frog Pond

The purpose of acquiring the Frog Pond and the Rocky Glades agricultural areas as a part of the recommended plan is to enable the hydrologic restoration of the headwaters and upper portions of Taylor Slough.

8.5.2 Environmental Information and Evaluation Comments/Responses

a. Buffer Zone Management

Land management practices for lands acquired for project purposes are discussed in paragraph 7.4.2.

b. Treatment for Water Quality

The issue is discussed in Section 2.3 of the report. The proposed project will not adversely impact the quality of State waters or those of Everglades National Park.

The Corps of Engineers does not propose water treatment areas or facilities as part of the project.

c. Cultural Resources

The requested professional investigations of tree islands or oak hammocks, if any should be projected to be affected by construction or operation of the project, will be done. A more detailed description of these studies is provided in section 7.12.

d. Effects on Dissolved Phosphorus In Taylor Slough

Criteria for total phosphorus concentration input at S-332 of 8-13 ppb by 2002. The criteria cited are mandated by the United States vs SFWMD et al. Settlement Agreement

e. Water Spillover from Shark River Slough at 6.5 feet elevation

The information is developed and reported by Tropical Bioindustries (TBI, 1990). The author indicates that the information is based on topographic data. Examination of the most recent topographic data collected by the Corps, SFWMD, and ENP (compiled by ENP) confirms this conclusion.

f. Florida Bay Description

The section on Florida Bay (2.4.2) has been revised for more precision.

g. Low Water and Decreased Nesting

The statement is attributed to ENP biologists.

8.5.3 Hydrologic Issues and Evaluation Comments/Responses

a. Was the model calibrated?

The SFWMD 1x1 model was calibrated for the time period 1983 to 1986 and verified for the period 1987 to 1989. Predictive confidence of the model is as good as a one square mile cell size model can be expected to perform. The primary purpose of this model was to compare alternatives and select a plan for detail design. Further design work will utilize the SFWMM 1x1 model as well as more detailed ground water models.

b. How do the water level differences between alternatives compare with the range of errors during calibration?

Water level differences between alternatives tend to be very close as can be seen in Tables A-6 and A-7. High horizontal hydraulic conductivity along with flat topography limit differences in elevations to tenths of a foot.

c. Is there enough pumping capacity?

The recommended plan includes a 63 percent increase in the discharge capacity for the area above S-177. This capacity, along with the buffer area to reduce back-seepage, will provide the design level of flood protection.

d. Do we run the risk of continuous pumping to make up for seepage?

The buffer strip is designed to reduce back-seepage. During storm events, the system was designed to pump over a longer period of time and remove the total volume of the storm rainfall. Extended periods of discharge are expected and operating costs reflect these expectations. The environmental consequences of continuous discharge is expected to be positive and more closely approach historical conditions and more water will be retained in the system.

e. Why is the buffer area needed?

The acquisition of land interests in the detention/retention area reflects damages from higher water levels. The detention/retention area is needed for storage and flow dispersion. The buffer area may have some surface ponding near the detention/retention area and will have higher groundwater levels than under pre-project conditions, thus increasing its susceptibility to flooding.

f. Could a more passive alternative be implemented that would require less land and pumping?

A seepage cut-off curtain wall alternative was evaluated in the revised report (section 5.6.4.10). However, cost and constructability in the limestone made this alternative less cost effective than the recommended plan.

g. How does capillary action impact the performance of the plan?

The model does not account for capillary action. Because of the high porosity of the Miami Oolite formation due to large solution holes in the limestone, there is little capillary action in most of the aquifer. However, near the surface where there are deposits of peat or marl, there may be some capillary action under some conditions. This issue is common to the existing condition and all alternatives and would not impact the evaluation of alternatives.

h. Will water stored in the upper 1.5 feet remain in storage for the duration of the storm?

Yes, 1.5 feet of groundwater storage is required. Whether this is the upper 1.5 feet depends on the land elevation and season of the year. Lands with less than 1.5 feet below the root zone may have an incompatible land use. The original design for the C-111 basin required 1.5 feet of groundwater storage.

i. What effects do the higher water levels west have on the pump capacities?

The buffer zone is designed to reduce the backseepage from the higher water levels to the west. There is 63 percent more capacity planned for the basin. Detailed design, using groundwater models with finer grid spacing will more accurately define pump capacity.

j. How do alternatives 4 and 6 raise water levels in Shark River Slough?

Normal groundwater slope and resultant flow is to the southeast from Shark River Slough. Plans 4 and 6 raise groundwater levels along the eastern boundary of Shark River Slough and decrease the hydraulic gradient. More water stays in Shark River Slough and flows toward Florida Bay. The higher boundary condition from Plans 4 and 6 also cause a steeper gradient toward L-31N and C-111. The buffer strip helps to mitigate this backseepage to some extent. Backseepage that does return to the canal is picked up downstream and returned to Taylor Slough. The system of pumps and groundwater storage is intended to keep as much water in the system as possible and make releases over an extended period of time.

k. Will the increased water levels in northern Taylor Slough impact the flood protection to the 8.5-square-mile area or increase the seepage to L-31N?

Modeling has not shown an adverse impact on the 8.5-square-mile area. More detailed groundwater modeling will be used to further quantify impacts. Higher seepage rates to the lower L-31N canal are expected and are accounted for in the design.

l. Grossman Road borrow canal

The Grossman Road borrow canal is not included in the model that was utilized for this study. It may have some local hydrologic impacts but it does not significantly impact the water management system. As a part of detailed design for the Modified Water Deliveries to ENP Project, an evaluation will be done of the hydrologic impacts of all existing roads and canals that are within the ENP expansion area. If it is determined that the roads or canals have a hydrologic impact on the natural conditions in the area, they will be restored to natural ground elevations.

m. Groundwater modeling for detailed design

As a part of the detailed design of the Modified Water Deliveries to ENP Project, the USGS has modified an existing model to provide adequate detail for the study area. The model is being utilized to predict seepage rates into the L-31N borrow canal that will occur as a result of restoration of Shark River Slough. The same model will be modified and utilized for the C-111 project detailed design studies.

8.5.4 Economic Evaluation Comments/Responses

a. Dade County Planning Department does not make recommendations on agricultural practices.

pg 2. paragraph 6, pg 3. paragraph 7. Concur. This reference has been deleted from the report. County polices listed in the Comprehensive Development Master Plan have been used, if appropriate to supplement the discussion on page E-2.

b. Personal income

In addition to reducing net benefits in the National Economic Development (NED) account, agricultural land purchases with project alternatives have regional (RED) effects. Direct losses which include loss of income and profit to producers and indirect losses which effect jobs, income, and employment in Dade County will occur. Estimates of direct losses to selected producers have been included in section 6.8 (Impacts on Agricultural Uses of Affected Lands) in the main report. Indirect effects are described in the "Effects Evaluation" table in section 5.9 of the main report. With the proposed plan the table indicates a moderate to major adverse effect upon regional income and employment.

c. Flood Damage Reduction (Problems and Opportunities)

The primary project purpose of the South Dade Conveyance System was to provide flood control protection to the South Dade County area. Even with authorized water levels in the canal system, one effect of project implementation was to reduce flood risk to the agricultural area. Shortly after implementation of the project, authorized stages were reduced in the canal system as a compromise action to further benefit the farming community. The Everglades restoration program was part of the original project authorization and not an afterthought as the original design was to allow for minimum water deliveries of 315,000 acre feet per year.

d. Agricultural encroachment

A better definition of agricultural encroachment is provided on page E-2. The encroachment discussed in the report is not caused by new agricultural development replacing existing wetlands. Two forms of encroachment are discussed. First with lower water levels, highly damage susceptible vegetable crops can be grown year around ather than just in the dry winter months which can increase flood damage susceptibility. Second, the amount of fruit tree crops and general horticultural activity have increased in the flood plain. Since these trees have longer root zones than other field crops, they are more susceptible to high water tables and to flooding than was the agricultural development in the 1960's. The paragraph in 4.3 will be revised to explain encroachment in these terms and delete the reference to agricultural expansion into wetlands. However, it should be noted that the original design of the C&SF Project for flood control in south Dade County did not intend to provide flood protection to any lands west of L-31N, i.e. the Rocky Glades agricultural area.

Agriculture is not bearing the blame for today's conditions. In fact, the reason for the flood control portion of the selected plan is to attempt to maintain flood control capacity for agriculture in the area east of C-111.

e. Root zone depth

A root zone depth of 2 foot for tree crops was used in the evaluation with a bedding height of 17 inches. Recent discussions with the IFAS in Homestead has indicated that fruit trees planted east of C-111 may have deeper root zone depths. If this is the case, there may be increased damage susceptibility east of C-111 that the project could prevent.

f. Federal Objective

The flood control feature of the NED account is improved since flood damage prevention increases with the selected plan. Positive flood control benefits accrue to the area east of C-111 when the without and with project alternatives are evaluated at authorized stage levels. Although project costs for environmental project purposes have been determined, NED benefits attributable to environmental purchases have not been determined. Therefore, the effect upon the entire NED account is not known. All costs and benefits that have been computed for the GRR will be shown in the Environmental Impact Statement under NEPA. The Other Social Effects account (OSE) and Regional Economic Development accounts (RED) are displayed and compared with the NED account in the "Effects Evaluation" table in section 5 in the main report. Negative effects attributable to agricultural land purchases are accounted for in the NED account. Lands purchased are a project cost and are displayed on an annual basis. The effect of increased project costs is to reduce the net benefits to the project and reduce the corresponding benefit-to-cost (B/C) ratio of the flood control portion of the project.

NED impacts have not been ignored. Flood control is an important project purpose. The NED plan is not identified in this report because the report objectives are slightly different than in traditional reports. The objective is not to maximize flood control protection but rather to maintain the level of protection provided by the original project under changing land use conditions.

g. Evaluation Factors

The list of evaluation factors constitutes a general method of evaluating plan performance relative to the project objectives. While all care is taken to minimize adverse impacts to RED and OSE, improving these accounts is not a project objective. Therefore, these issues are not included in the section "Evaluation Factors". As stated previously, negative effects of agricultural land purchases are included in the NED account.

h. Preliminary Analysis of Annual Benefits and Costs

As mentioned previously, the objectives in this report are slightly different than in traditional reports. The flood control objective is to maintain the level of protection provided by the original project. All plans evaluated include a flood control component to provide the stated protection. Therefore, the flood control component benefit-to-cost ratio for all plans is close to identical to the B/C ratio computed for alternative 1A. Environmental benefits of the project cannot be quantified in terms of economic value. To compare total benefit-to-cost ratios without including environmental benefits would be misleading.

i. Effects Evaluation

The effect of land purchases is to remove cropland from production and therefore reduce damage susceptibility in the study area." This statement found on page E-2 of the report is incorrect. A procedural error in benefit calculation caused flood control benefits to increase. Flood damage susceptibility was calculated on purchased lands for the without condition. However, flood damage susceptibility on these lands were removed for the with project condition. The incorrect calculation of without project flood damage caused flood damages prevented (the difference between without and with project) to increase as additional lands were taken out of production. The damage reduction benefits shown for purchasing agricultural areas will be removed from the final report. However, this change will not affect Alternative 1A (flood control plan), or any economic conclusions in the report. The statement was not intended to imply that purchase of agricultural lands is the most cost effective means of achieving flood control.

j. Displacement of People, Businesses and Farms

Information has been added to this section of the draft report.

k. Maximization of net benefits

"All plans provide approximately the same net flood protection benefits. Therefore, the plan selection becomes totally a function of environmental efficiency.". The statement is found in the "Maximization of Net Benefits" subsection which describes a basis for plan selection for the NED account. The NED account properly identifies the adverse effect of land purchases by treating the purchases as project costs. Discussion of regional impacts is inappropriate in this section.

l. Economic evaluation of agricultural flood damages

The University of Florida Institute of Food and Agricultural Sciences (IFAS) provided valuable input to the development of the economic evaluation procedures used for this report. Comments were provided in response to a request for a preliminary review of the evaluation procedure. Although these comments were not directly related to the preliminary draft GRR, they are addressed below:

Part I - General Assumptions Concerning Damage Susceptibility.

1. "Although your assumption of an average 17 inch bedding elevation seems reasonable, under non-flooded conditions the tree will establish roots throughout the bed and to the bottom of the tree trenches (another 18-24 inches). Periodic and/or constant flooding (e.g., a periodic flood depth 6 inches up onto the bed) will stress and most likely kill all roots from the flood line down and drastically reduce the non-flooded root mass. This would result in the above ground part of the tree (the top) dieing back due to any number of factors including a lack of oxygen, water and nutrient uptake, and uptake of phototropic substances. In addition, the stability of the trees due to high winds or a hurricane would be drastically reduced.

Concur. The text discussion notes on page E-7 that root zones for fruit trees can generally range from 12 to 30 inches deep. A root zone depth of 2 foot was used in the evaluation with a bedding height of 17 inches. Therefore, the benefits are considered reasonable in respect to this assumption. Increasing root zone lengths for fruit trees east of L-31N would have the impact of increasing damage susceptibility under the without and with project conditions and increasing project benefits.

5. The assumption is made that operating costs for fruit trees per year are estimated to be approximately $100 more than land rent for all fruit tree classifications. "Not clear to me what you mean. The operating costs for fruit trees

per year are different for each fruit crop and are separate and do not include land rent charges." (referenced table not provided).

Concur. The Operating Costs provided in table 1 are utilized for fruit production losses. Additional operating costs for tree maintenance was the information provided.

8. Your letter includes the reference "Operating and fixed costs for mangos are higher than other crops due to increased need for insecticides and spraying". Please change first sentence to read: Operating and fixed costs for mangos are higher than other crops due to increase need for pesticides (fungicides in particular) and spraying."

Concur. Text refers to a supplemental information sheet not in the draft or final report.

10. Your letter includes the reference " A reasonable range of operating and fixed costs for carambola would be approximately $2,000 to $2,500 per acre. A value of $2,250 will be used in this analysis. The reason for the high cost is primarily due to proration of additional fixed costs for man-made windscreens necessary to keep crops from blowing over." Please change the third sentence to read: The reason for the high cost is primarily due to the proration of additional fixed costs for man-made windscreens necessary to keep crops from wind damage.

Concur. Text refers to a supplemental information sheet not in the draft or final report.

Part II - Other Considerations.

1. No where in you calculations do you indicate what the loss is to the producer for his/her sold product due to flooding. In other words, if a producer is getting $2.50/pound for their fruit and the trees are producing 100 pounds per tree and there are 120 trees/acre, that is a $30,000 loss. Furthermore, this income loss would increase substantially for fruit crops that normally bear more than on crop per year (e.g., limes, carambolas). In addition, trees that have withstood flooding previously may not produce a crop the following year or years depending upon the extent of damage due to the flooding.

An estimate of the value of the fruit crop on the tree (before harvesting costs) can be approximated by using operating costs, fixed costs, and land rental values to produce the crop. This is based upon the fact that production costs which include all land, labor, and capital costs and returns to land and management should be equal to the revenue produced. When fruit is harvested, production costs are recovered. Therefore it is inappropriate to claim both production costs and losses of the value of the fruit. If a flood occurs before the fruit is harvested production costs or the value of fruit can be claimed but not both.

2. In general, fruit trees with fruit on the tree are generally more susceptible to flooding damage than trees that do not have fruit. In fact, the presence or absence of fruit may mean the difference between tree survival or death. An example is avocado. Observation has indicated, trees with fruit die more quickly or are more damaged due to flooded conditions.

Concur.

3. Trees that are damaged due to flooding are more susceptible to other environmental stresses (e.e., cold, drought, hurricane). A typical scenario is trees are flooded and their root system is damaged. During flooding, the tree top may have sustained some leaf drop, necrosis, and stem tieback. The flood water recedes and the soil profile is reoxygenated. However, even though the trees are no longer flooded the tree tops continue to drop leaves, stems die back or the tree dies. This is because during the flooding event water uptake is reduced due to necrosis of the root system and because physiologically the capacity of the root system to transport water is decreased or stopped. Subsequently when the soil is drained, the smaller root system does not have the capacity to move enough water to satisfy the demand of the top (leaves and stems) and the tree continues to die back or die all together.

Concur.

4. Trees that survive an environmental stress need non-stressed conditions, sound cultural practices, and time to recover. In general, if trees are repeatedly stressed (e.g., periodically flooded) they will be stunted in growth (non-vigorous) which will delay and/or prevent canopy development and thus the tree will never reach their fruit bearing potential, continue to die back slowly and/or eventually die, and remain more susceptible to other environmental stresses (i.e., freezes, hurricanes). Thus fruit production would be reduced or eliminated in subsequent years.

Concur. This is accounted for using the additional operating costs necessary to produce a healthy mature tree after a serious flood.

5. No where in your calculations are the management problems for the producers included. Tropical fruit crops have to be managed year round. Periodic flooding may cause problems which include inaccessibility to the grove for timely fertilizing, mowing, herbiciding, spraying (nutritional and pesticidal sprays), and harvesting; increased weed growth; increased chance for fertilizer leaching; delayed or prevented fruit harvesting; increased cost for control of root disease problems and; increased maintenance costs on machinery that gets wet or that works in excessively moist

conditions. All these problems would lead to reduced fruit production and profitability of the operation.

Concur. Managerial labor costs and returns to managerial efficiency are not included in production costs. Insufficient information exists as to the quantity of these costs.

6. Several producers in the affected area ('west of the dike') have indicated that the current increase in the water level (during 1993) has already affected their grove operations (e.g., equipment maintenance) and increased production costs.

Concur. Water levels west of L-31N have increased in CY-1993 due to the Taylor Creek Demonstration Project. Without additional drainage, higher water levels will cause additional problems and increase production costs.

7. Soil flooding constitutes excessive soil moisture (continuously at or above field capacity). The excessive soil moisture may be visible above ground or may be at or below soil level (perched water table). Flooding may occur periodically or continuously.

Concur. Flood damage susceptibility is measured at the bottom of the root zone.

8.6 COMMENTS AND RESPONSES ON THE DRAFT INTEGRATED GENERAL REEVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

The draft integrated general reevaluation report and environmental impact statement was sent to numerous local, State and Federal agencies and provide interest groups for review and comment in accordance with the Council on Environmental Quality's NEPA regulations and related Corps guidance on March 4, 1994. Comments received during the review were considered in preparing the final study documents, and will be considered by subsequent reviewers and decision makers in the Washington level Federal review process. A copy of these letters are located in Annex A of this report.

Written comments on the report were received from the following:

Federal Agencies

U.S. Department of Agriculture
U.S. Department of Commerce - Florida Keys National Marine Sanctuary
U.S. Department of Commerce - National Marine Fisheries Service
U.S. Department of Interior - Everglades National Park
U.S. Environmental Protection Agency

U.S. Fish and Wildlife Service
U.S. Soil Conservation Service

State Agencies

Florida Department of Community Affairs
Florida Department of Environmental Protection
Florida Game and Fresh Water Fish Commission
Florida Division of Historical Resources
Florida Department of Transportation

Local Governments

Metropolitan Dade County
Miami-Dade Water and Sewer Authority Department
Monroe County
South Florida Water Management District
South Florida Regional Planning Council
Institute of Food and Agricultural Sciences, University of Florida

Groups

Audubon Society of the Everglades
Everglades Coalition
Everglades Outward Bound Center
Environmental Defense Fund
Florida Lime and Avocado Administration Committees and South Dade Land Corporation (Ghioto and Associates)
Izaaak Walton League of America, Florida Division
Lake Region Audubon Society
National Wildlife Federation
Oklawaha Valley Audubon Society
Orange Audubon Society
Sanibel-Captiva Audubon Society
Sierra Club, Broward County Group
Sierra Club, Loxahatchee Group
The Nature Conservancy
Tropical Audubon Society, Inc.

Individuals

Over 120 individuals wrote the Corps during the NEPA review period to express their views on the C-111 project.

The following discussion summarizes comments received during the review and provides responses and/or describes how the comments were addressed in this report.

8.6.1 Plan Formulation Comments/Responses

a. Scope of Project

The study basin's northern boundary is a line drawn east and west from the southern boundary of the 8.5 square mile area as shown on Figure 7-1. The 8.5 square mile area is not part of this study.

The scope of the Federal Project is to restore more natural hydrologic conditions in the C-111 basin, including Taylor Slough while maintaining flood control capability. The Model Lands area (land between U.S. Highway 1 and Card Sound Road) are not within the study area.

Florida Bay is directly affected with restored natural flow to Taylor Slough and the east panhandle of the ENP, but is not an objective of this study. The reduced fresh water inflows from the C-111 system have been linked to the decline of Florida Bay and for this reason, the Corps is restoring flows to Taylor Slough and the eastern panhandle of the ENP. The C&SF Comprehensive Review Study, also conducted by the Corps, will address Florida Bay.

b. Culvert under Highway 1

It is assumed that the culvert under the highway will be constructed by Department of Transportation as a part of the construction of widening the highway. The culvert is not included as a C-111 project cost.

c. S-197 Operation

A discussion was added to the final report (see section 2.2.3), describing the operational plan is not to open S-197 unless absolutely necessary. Flows will be discharged at S-18C and will overflow the southern bank of C-111 into ENP. Construction of 10 additional culverts at S-197 by SFWMD has provided much greater operational flexibility. All alternative plans considered would reduce the potential need for sustained discharges through S-197 into Manatee Bay/Barnes Sound.

With the recommended plan, flow releases decreased by near 39 percent. Further reductions are likely through changes in operation for this structure.

Increasing the stage at which S-197 discharges flood waters would result in reductions in volume releases. Volumes not released by S-197 would increase sheet flows south of the lower C-111 canal thus bringing greater environmental benefits for this area.

d. Flow Across the "Gap" Area of Lower C-111

The spoil will be removed from the lower C-111 to promote sheetflow across this area. Where the current tendency is for water to exit the eastern gaps near US Highway 1, this will be modified to promote an even flow across the section.

e. Department of Environmental Protection (DEP) New Plan

DEP's modified alternative 6A is still very similar the Park's Concept 8. Alternative 6A was derived to address the same goals as this plan. Maintaining the lower section of C-111 will provide operational flexibility for discharge of excess flood waters or to provide supplemental discharges to northeast Florida Bay by keeping S-197 closed and allowing overflow from the canal. Also, gravity flow will be used to accomplish this, as opposed to pumping this water. The Corps disagrees with your plan to leave L-31W and cut off the natural flow of Taylor Slough. The size of the retention/detention zone will be optimized during the design phase of the project.

Canals C-109 and C-110 will be plugged in an effort to prevent shortcircuiting the wetlands, which is more inexpensive than total backfill.

The size and location of S-332E and the spreader canal (C-111N) will be optimized during the design stage of the Corps project to minimize adverse impacts on private lands.

DEP's proposed plan calls for water to pass from C-111 to the surge reservoir and back to C-111. This water will not be sent to Taylor Slough which is one of the Federal objectives.

f. Curtain Wall

The agricultural community has proposed a plan which would surround the agricultural areas with a curtain wall. This plan was evaluated as alternative 9 and is described in section 5.6.4.10. This curtain wall would have to extend through the Biscayne aquifer to a distance of about 60 feet. The purpose of this proposal was to create a barrier between ENP and the farm land, without taking the farmland out of production. Seepage losses from ENP towards L-31N would be reduced considerably. Several plans were developed, including metal and plastic sheetpile and a slurry trench. The most cost-effective method was a Gundwall plastic sheetpile with hydrotite, which cost approximately $6,623,000 per mile. Using lands developed under plan 6, the cost of the sheetpile wall was approximately $102,000,000 versus the cost of purchasing these lands at $50,690,000.

A 2-dimensional finite element program was used to calculate the quantity of seepage beneath a fully and partially penetrating barrier. This analysis showed that an impermeable cutoff must extend the full depth of the aquifer to be effective. If the cutoff partially penetrates the aquifer, additional pump stations would be required to handle the resulting backseepage. This additional cost may make a partially penetrating cutoff much more expensive than a fully penetrating one.

The most difficult and potentially expensive portion of this work is the excavation of a trench through the limestone to the base of the aquifer. Estimates from various contractors involved with this type of work range from $15 to $20 per square foot of wall placed (without government E&D and S&A). Even these costs range from $71,000,000 to $95,000,000 for a 55 foot deep wall. However, all of the contractors contacted during this investigation have stated that trenches have not been excavated to the depths required by this project in rock materials.

This technology is new and the Corps will continue to assess its applicability to this or future work. Regional and local effects of this technology will be further assessed in the design phase of the project.

g. Hole-in-the-Donut Restoration

Early estimates for completion of the project are 15 years. With the uncertainty of this project, the fill material from this area was not considered for the proposed levees. Also future with and without project conditions did not consider this alternative.

h. Water Supply Preserves

The water supply preserves suggested by the National Audubon Society are outside the scope of the C-111 basin. Alternative 6A addresses their issues on a smaller scale, including water retention/detention, buffer zone, spatial distribution of water and water quality. Furthermore, if the water supply preserve plan is later adopted for implementation, the plan recommended in this report would be consistent with this concept and could be incorporated into a more comprehensive regional plan.

i. Scope

To rehydrate lands east of U.S. Highway 1 is outside the scope of this project. These lands are not part of water supply to Everglades National Park. Ideas developed outside the scope of the project can be addressed as locally preferred features of the selected plan at a 100 percent non-Federal cost. The Federal project is shown in Alternative 6A.

j. Backfill C-111

Preliminary data developed at the SFWMD showed that the backfilling of C-111 caused a reduction in water moved to the land south of the lower section of C-111. This in turn was detrimental to the ecological balance in lower C-111. It is unknown at this time if operational studies can rectify this situation, but the Corps will continue to investigate this possibility during the design phase. In 1990, the SFWMD replaced the plug in lower C-111 with 10 culverts. This action will greatly will greatly reduce the likelihood of major damaging discharges to Manatee Bay/Barnes Sound. All of the culverts have been opened once since their construction and no significant effect has been measured. Since groundwater flow is in a southeast direction, the flow of water in the lands north of C-111 will flow to the southeast and away from ENP, and not to the western portion of the eastern panhandle of ENP. In the operational phase, S-197 will be closed and water will gravity flow south across the ENP into Florida Bay.

The lower C-111 canal provides gravity conveyance to the panhandle area of ENP both during droughts and during floods. Our period of record modeling indicates higher water table levels and longer hydroperiods in the panhandle with the existing canal in place. Also, during flood events the capacity of the gaps can be improved to retain the flood flows in the ENP and eventually add freshwater seepage into hypersaline eastern Florida.

k. Plugging C-109 and C-110

The proposed plan includes plugging of the C-109 and C-110 canals thus eliminating their function. With the proposed plan releases through S-197 will decrease considerably. Releases through S-197 depend on how the system is operated.

l. Full Restoration

None of the plans modeled will achieve full restoration. The intent of this study was to analyze the best way of achieving the objectives by providing structural capability to control the location, timing, and quantity of discharges with available water. During the design phase of the study, and subsequent studies like the C&SF Comprehensive Review Study and Modified Water Deliveries to ENP, plans to bring more water to the C-111 basin will be developed, which will work towards restoration of the C-111 basin.

m. Operational Criteria and Studies

Sections 5.4 was added to describe operational criteria used to evaluate all alternative plans. An important objective of this project is to provide a structural system that is adequate to provide the operational flexibility to restore more natural hydrologic conditions in Taylor Slough. Operational studies to identify an optimal operating plan will require additional data collection and evaluation. In order to expedite the resolution of environmental problems in the park, design and construction of the desired structural features will proceed while the operating plan is being defined. As described in a section 7.9, the operating plan for Modified Water Deliveries Project will be coordinated with the C-111 operating studies.

The GRR does contain operating criteria. All alternatives were evaluated using the design optimum canal stages for the South Dade Conveyance Canals. However, it is recognized that in order to maximize the environmental benefits while maintaining other authorized C&SF project purposes, additional studies are needed.

Operational studies will be coordinated as soon as the GRR is approved.

n. Evaluation of Alternative Plans

In the evaluation of plans, the objectives are discussed in Section 5.2 and described in Sections 5.2.1-5.2.4. The evaluation factors are discussed in Section 5.5 and described in Sections 5.5.1-5.5.4. Both Table 5-8 and 5-9 are used to select a plan. A plan was selected which met all the objectives and was the least cost.

o. Width of Levee Crown

Corps standards for levee construction include a crown width of 15 feet.

p. Federal Objective

Both negative and positive impacts have been addressed in the report.

q. Flood Control

There are measurable flood damage reduction benefits for each plan.

r. 8.5-square-mile area

A more detailed description of the entire Modified Water Deliveries to ENP Project has been provided in the "Future Without Project Condition" section. Additionally, information has been added in a new section "Integration of the Recommended Plan with the Modified Water Deliveries to ENP Project." The recommended plan calls for construction of a levee, seepage collection canal, and a pump station, S-357, to prevent adverse impacts to the 8.5-square-mile area as a result of restoration of Shark River Slough. Legislation has been enacted authorizing the Department of Interior to utilize previously appropriated funds to contribute up to 25 percent of the cost of acquiring the 8.5-square-mile area, the Rocky Glades agricultural area, and the Frog Pond. The acquisition would be a cooperative effort by SFWMD, DOI, the State of Florida, and Dade County. If the land is acquired, there would be no adverse impact on the recommended plan.

s. S-331 Operation for Recommended Plan

S-331 will be operated as it is designed with implementation of the recommended plan. It will be used for water supply deliveries to the ENP-South Dade County Conveyance Canal system when water levels drop 1.5 feet below their optimum levels in the downstream reaches. The pump will not continue to be used to prevent flood impacts in the 8.5-square-mile area.

During non-flood conditions, excess seepage water from Shark River Slough could be pumped southward. S-331 is currently not operated like this.

t. Project Purpose for Flood Control

One of the objectives of this report is to maintain flood control in the C-111 basin east of L-31N and C-111. The use of the retention/detention area has been implemented to prevent release out of S-197. This improvement in outlet capacity is 39 percent increase over the existing condition.

u. Project Purpose for Acquisition of the Frog Pond and Rocky Glades

The purpose of acquiring the Frog Pond and the Rocky Glades agricultural areas as a part of the recommended plan is to enable the hydrologic restoration of the headwaters and upper portions of Taylor Slough.

v. Timing of Water Deliveries with Alternative 6A

The timing of water deliveries was not optimized at this stage. The use of culverts and the overflow weir will have the potential to return to a more natural timing of water releases to the ENP. Also, with the use of the pump stations, a seasonal distribution can be analyzed.

w. Concrete Lined Canal at S-332D

The concrete lined canal will be connected to the outlet side and discharge 0.5 mile west through the new S-332D tieback levee into the retention/detention zone.

x. Acquisition of Agricultural Lands

The acquisition of agricultural lands are not an objective of this report. The use of a curtain wall instead of acquiring the lands has not been ruled out.

y. River Basin Monetary Authorization & Miscellaneous Civil Works Amendments Act of 1970.

The reference to this act was not the canals, but the formula of delivering water to the ENP, specifically the use of 315,000 acre feet of water. The formula in the Act was never used and another formula was later developed. The canals in question were not built.

z. Prior Plan Formulation Studies

Prior plan formulation studies from the 1988 GDM are located in Appendix F.

aa. Damaging Fresh Water to Barnes Sound

Section 5.2.3 was inadvertently left out of the report and has been included in the final GRR.

ab. Flexibility

A flexibility to maintain flood control for the areas east of L-31N and C-111 was added to Section 5.5.1. Flood protection is evaluated for lands east of L-31N and C-111.

ac. Flows Collected in Canals

This paragraph, section 4.1, 3rd para., has been modified. These flows are collected in the canals and are discharges for the most part to Taylor Slough (at S-332), to the park's panhandle via S-18C and lower C-111, and to Manatee Bay/Barnes Sound under extreme conditions.

ad. Interim Plan

Section 1 of the GRR is an introduction. Canal stages are discussed in Chapter 2.

ae. Selection on Recommended Plan

Plan 6A was selected because it meets the overall objectives of maintaining flood control while permitting environmental restoration within ENP to occur.

af. Public Review and Meetings

The draft C-111 GRR and Integrated EIS was coordinated for review with federal, state, and local agencies, as well as the public between March 4, 1994 and April 18, 10994. Also when the operating plan for the structures is formulated, it will be coordinated for independent review. Agricultural and environmental interests have been included.

ag. Design of Recommended Plan

The design phase for the C-111 basin will address specific details and design issues. This study will include extension of the buffer strip, location of the spreader canal, size of S-332E, and plugging, filling, or other options for the lower C-111 reach. As well as potential impacts to Florida City.

ah. Miscellaneous Editorial and Printing Errors

The Corps has tried to correct the miscellaneous typographical, editorial, and printing mistakes.

8.6.2 Environmental Information and Evaluation Comments/Responses

a. Buffer Zone Management

Land management practices for lands acquired for project purposes are discussed in paragraph 7.4.2. A cost of $15 per acre per year was provided by the SFWMD for land management.

b. Treatment for Water Quality

The issue is discussed in Section 2.3 of the report. The proposed project will not adversely impact the quality of State waters or those of Everglades National Park. The Corps of Engineers does not propose water treatment areas or facilities as part of the project.

Water quality effects of detention/retention zones are addressed in Section 6.6. The subsoil in the Taylor Slough--C-111 area is highly porous and cavity-riddled limestone incapable of supporting surface water except when the ground water is at the surface.

c. Cause of Seagrass Die-off in Florida Bay Are Not Thoroughly Known.

Concur.

d. Statements in the document regarding effects in Florida Bay should be carefully qualified to avoid inferring unjustified blame:

Concur; inferences that may be perceived are not always anticipated.

e. Excessive phosphorous levels are "believed to be a result of increasing agricultural use and changes in land use in the Taylor Slough Watershed." Who believes? Documented fact? Are areas north of Tamiami Trail included in this reference?

This is hypothesis, referring to land uses in the entire Everglades watershed.

f. Impacts on listed endangered or threatened species:

Fish, wildlife, and endangered species responses to the recommended plan will depend on seasonal water availability. This will be forecast during operational studies. The recommended plan has the greatest potential for meeting the criteria.

g. Restoration of natural fire regimes:

To the extent that the objective (section 5.2) of restoring historic hydrologic conditions is reached, restoration of natural fire regimes will be possible.

h. Control of nutrients and other water pollutants:

The recommended alternative will not exacerbate water quality problems in Florida Bay.

i. Imposition of best management practices in Taylor Slough watershed:

Imposition of best management practices on agriculture in the area is not part of the plan recommended by the U.S. Army Corps of Engineers.

j. "Without project" effects on Florida Bay ecosystems:

As stated in Section 2.4.7, restoration of more natural hydrology in the Taylor Slough--C-111 basin would correct one of the major problems in Florida Bay. However, "without project" conditions probably do not include all the documented problems in Florida Bay.

k. Environmental benefits of various components of the integrated estuarine and marine ecosystem structure and functioning as evaluation criteria:

The environmental evaluation criteria presented in Section 5.5.3 are regarded as the basis for the adequate structure and function of the various components of the ecosystem. The components, such as mangroves, fringing marshes, and seagrass meadows, are not evaluation criteria because they are the results of, not the basis for, a more natural hydrological regime. As indicators of a healthy system, they are reliable, but slow in responding.

l. The desirability of natural fires vs prescribed burning:

The comment is noted for future reference in development of management and monitoring protocols.

m. Recommendation of a complete review and evaluation of all historical and current information to define natural ecological functions:

Such a review has been underway as a cooperative effort between ENP and the USACE. This is expected to continue as part of the operational evaluation phase.

n. Begin development of a fine scale natural systems model capable of providing an estimate of pre-project hydrologic conditions:

Such modeling has been underway cooperatively by the SFWMD and the ENP.

o. Create a comprehensive hydrologic and biologic monitoring program:

Concur that this is a high priority task during the operational evaluation phase. Funds have been added to create the monitoring program and an outline is included in Annex H.

p. Concerns over the actual functioning of the project to be developed:

All concerned agencies, including the EPA, will be kept informed and their counsel will be welcomed during the operational evaluation phase.

q. Water Spillover from Shark River Slough at 6.5 feet elevation

The information is developed and reported by Tropical Bioindustries (TBI, 1990). The author indicates that the information is based on topographic data. Examination of the most recent topographic data collected by the Corps, SFWMD, and ENP (compiled by ENP) confirms this conclusion.

r. Lack of Scientific Data linking water quality and agricultural practices in South Dade County

The Corps has no data that show a statistical correlation between South Dade County agriculture and water quality in the canals.

s. Positive Effects of Alternative 6A

The Everglades represents marginal habitat quality for most of the species of concern, and restoring the habitat to historic-like conditions of low nutrients and low productivity, although helpful to individual populations, would not greatly help the species.

t. Water Quality of Areas North of the Tamiami Trail

Water quality in the northern Everglades refers to areas north of the Tamiami Trail. The reference is made to water brought into Dade County from the north.

u. Specific question asks whether data support the inference that lowered water levels caused adverse changes in nesting success of wood stork, Cape Sable sparrow, and roseate spoonbill.

The conjecture is based on professional judgement expressed by ENP biologists.

v. Specific question asks (a) whether the cost of the proposed project is justified by the projected, small effects on species listed under the Endangered Species Act, and (b) asks for explanation of the statement in the report that proposed project works may give better results under "a different water control schedule."

(a) The Everglades represent marginal habitat quality for most of the species of concern, and restoring the habitat to historic-like conditions of low nutrients and low productivity would not greatly help the species. The C-111 restoration proposal, in itself, would not greatly favor one species or another, but would contribute to the recovery of the greater Everglades in combination with Modified Water Deliveries to ENP and associated effects in the Water Conservation Areas. Wide-ranging species, such as wading birds, would benefit from the wet-dry pulses in the greater restored portion of the Everglades.

(b) The quoted phrase was not found in the cited paragraphs, nor in adjacent ones in the draft GRR/EIS.

w. Specific question interprets a statement in the report to mean that South Dade agricultural practices and resources are one with those farther north, and expresses the opinion that retention areas or flow-ways would not function well in the C-111 area.

The Corps has no data that statistically link South Dade agricultural practice with water quality problems. Retention areas and flow-ways would be those, or similar to those, that are part of the Alternative 6A plan.

8.6.3 Hydrologic Issues and Evaluation Comments/Responses

a. Will increased water levels in northern Taylor Slough impact flood protection to the 8.5-square-mile area or increase the seepage to L-31N?

Modeling has not shown an adverse impact on the 8.5-square-mile area. More detailed groundwater modeling will be used to further quantify impacts. Higher seepage rates to the lower L-31N canal are expected and are accounted for in the design.

b. Grossman Road Borrow Canal

The Grossman Road borrow canal is not included in the model that was utilized for this study. It may have some local hydrologic impacts but it does not significantly impact the water management system. As a part of detailed design for the Modified Water Deliveries to ENP Project, an evaluation will be done of the hydrologic impacts of all existing roads and canals that are within the ENP expansion area. If it is determined that the roads or canals have a hydrologic impact on the natural conditions in the area, they will be restored to natural ground elevations.

c. Groundwater Modeling for Detailed Design

As a part of detailed design studies of the Modified Water Deliveries to ENP Project, the USGS modified an existing model to provide adequate detail for the study area. This model is used to predict seepage rates into the L-31N borrow canal that will occur as a result of restoration of Shark River Slough. The same model will be modified and utilized for the C-111 project detailed design studies.

d. Salt Water Intrusion

The South Dade Conveyance Canals were designed for a variety of purposes including the prevention of salt water intrusion. The operating criteria for those canals allow water to be brought in from other sources when the canal stage falls 1.5 feet below the design optimum stage. This operating constraint will be maintained. However, a detailed analysis of salt water intrusion in the C-111 system may be appropriate for the operation studies which follow the GRR.

e. Backpump Coastal Canals C-102 and C-103 for Additional Water

The proposal to backpump at the coastal canals C-102 and C-103 for additional water was investigated by the SFWMD for the Taylor Slough Demonstration Project. The SFWMD performed a field test at structures S-194 and S-196 in the spring of 1992 with portable pumps and concluded that backpumping was not very effective and therefore that increment was deleted from the test. However, in the operating studies which follow the GRR, it may be appropriate to assess that option for additional water.

f. Storms of June 1988

Although many secondary drainage systems rely on gravity, it may be appropriate to construct canals and pumping facilities to remove water in the area cited.

g. Storms of August 1988

The operating criteria used for S-331 during the August 1988 storms required it to pump in response to water levels at Angels Well. These operating criteria were developed as a result of the Kendall vs. Marsh litigation. It should be noted that if this test were not in place, then canal stages would have been at their design optimum stage in the southern portion of the C-111 basin and the results may have been the same in regards to the removal of the plug at S-197.

h. Optimum Water Levels

Table A-5 contains the design headwater and tailwater and optimum water levels used in the model.

i. Base Condition Used

The Base Condition used was selected based on the return to design optimum conditions upon completion of the Modified Water Delivery Project. At that point, Congress has mandated the Experimental Delivery Program will end. It should be noted all alternatives were evaluated using the same set of assumptions and compared to each other. The selected alternative 6a performed the best given this set of assumptions.

j. Inclusion of the 1992 Water Deliveries GDM

Agriculture moved in west of L-31N canal when water levels were lowered in response to the Kendall vs. Marsh litigation.

k. Inclusion of C-111 Interim Plan

Prior to the experimental program beginning and the Kendall vs. Marsh litigation, water levels in the South Dade Conveyance Canals were kept at their design optimum of base condition for the GRR. In response to the litigation, and to continue the experimental water delivery program, water levels in the southern portion of the C-111 basin were lowered as a trade-off for water deliveries into Shark Slough.

l. Operational Plan for Modified Water Deliveries to Everglades National Park

The approved Modified Water Deliveries General Design Memorandum (GDM) evaluated four operational schemes. Because there was no consensus it was decided to recommend structural features and refine the operating scheme. However on pg 59 of the GDM the following statement is made, "If an acceptable operational strategy has not been developed at the end of the iterative process, the Modified Rain Driven Operational strategy addressed in this report will be the water control plan when construction of the structural features is complete."

m. Retention/detention Area

The retention/detention area will serve several purposes. First, it will allow temporary storage of excess flood waters for use during times of deficient rainfall. Secondly, it will permit water managers the flexibility to release water into the ENP at various points in various quantities. Third, it will serve as a buffer area, maintaining high groundwater in the ENP to the west and allow the gradient to reduce to the east. Last, there are water quality benefits which have not been quantified in retaining the water prior to release into ENP.

Construction of a retention/detention area will be addressed during the design phase of C-111 project. One major issue concerning this measure is the high permeability of subsoil in the area. Soils of this type do not retain water for long periods of time. Another concern is potential flooding of areas upstream of a retention/detention area. When a ponding area is being filled, it creates a water mound that drastically reduces normal draining and produce longer hydroperiods in upstream areas. This effect was found during analysis of the retention/detention area west of L-31W in alternative 3.

n. Salt Water Intrusion

An important issue with a plan that includes a curtain wall for controlling seepage is the impact of salt water intrusion in the region. During droughts the fresh/salt water balance is sometimes upset and thus more salt water intrusion results from this imbalance. Numerical models used in the past and during the GRR are not capable of handling variations in water density. Search for a suitable model that includes the effects of a curtain wall salt on water intrusion is already in motion.

o. Rehydration of Taylor Slough

Rehydration of Taylor Slough headwater is the project purpose. Delivery of enough water to rehydrate the headwaters area and keep flood flows within the system are the basis for design of the pumping system. Continuous pumping would result in overdraining of groundwater near the canals and a mining of water. Experience has shown at S-331 it is possible to overdraw local groundwater and artificially reduce canal levels. Operational studies are intended to set start/stop pump stages so that these conditions do not occur.

p. Use of the 1x1 Model

The 1x1 model was the best tool available to assess damages throughout the C-111 area. Although the model uses a one day time step and therefore will not predict a 12 hour flood behavior, stages in the area do not change rapidly. It takes days and sometimes weeks for stages to change significantly. Therefore, if damages were to occur in a specific area, the 1x1 would predict those damages with a good degree of accuracy.

The 1x1 model uses a one square mile gridcell as a unit value to simulate hydrologic changes in the C-111 area. Because of the unique subsurface soil in the area and a very flat ground surface, water stages whether below or above ground change very little from one grid cell to another in general. A one mile gridcell therefore is enough to estimate damages and rate alternatives.

q. Modeling of Channels

The 1x1 model still uses a single reach between structures to compute volumes of water in that particular reach. This is done to approximate a mass balance of water available for routing downstream. However, seepage inflows to a channel reach are computed on a gridcell by gridcell basis and considers canal stages at each gridcell. Canal stages in a particular reach represent the stage at the downstream end of the reach between two structures. Therefore, calibration of the model compares the headwater at the downstream structure for each reach between two structures.

r. Physical Model Input Data

The data in the model reflects average ground elevation. As mentioned before changes in ground elevation in the area is gradual with very mild slopes. Today, a model that would reflect a more accurate representation of the land elevations in the area is not available. The 1x1 model is the best available tool for use in the C-111 area to evaluate alternative plans.

s. Boundary Conditions

Rainfall frequency storm events are modeled to assess their effects throughout a specific area. Boundary conditions do not include any effects of storm surges in the area, since it would worsen conditions for all conditions including the base. Storm surges would occur with and without the proposed plan and are not the focus of this study. A storm surge is another source of flooding. The focus of the study was to assess alternative plans and to insure private lands were not adversely impacted over the base condition.

t. Calibration and Verification

The 1x1 version used in the C-111 GRR was calibrated by the South Florida Water Management District in 1992. Historical and simulated stages at selected points were compared. Full details and results of the calibration runs can be obtained from the Lower District Planning Division of that agency.

u. Seasonal Flood Occurrence

The chance of damaging rainfalls occurring from November 1 through March 31 in any given year is the same with or without the project. During this period water deliveries to the C-111 basin are for water supply and for control of salt water intrusion. These dry season water deliveries do not increase the chance of flooding in the area.

v. 1x1 Modeling

Flood modeling utilized the most current version of the SFWMM 1x1. Canal conveyances are computed using existing canals (with South Dade Conveyance System completed). Plates showing canal dimensions were used to show typical canal/levee configurations and were not used for computations.

Concur - More detail models are needed to fully evaluate local impacts. Models used in this study were primarily used for alternative selection.

w. S-332E

Concerning S-332E, a similar effect was noted in areas north of the spreader canal. A sensitivity analysis of the pump station feeding this canal gave preliminary information about potential impact with a larger pump station. When S-332E capacity was increased from 50 to 100 cfs, backwater effects were found in areas up to five miles north of the canal. This issue will be addressed during the design phase for C-111.

x. Canal Stage Operation

Under the Experimental Program for Water Deliveries to ENP, canal stages in the C-111 area in general are operated lower than authorized. Alternatives in the GRR were modeled to simulate conditions before the Experimental Program. All the alternatives in the GRR were modeled with a fixed amount of water deliveries to the basin. This was done to ease model output analysis. In the operations study water deliveries to the C-111 basin would vary. This will increase the chances of restoring Taylor Slough and the eastern panhandle of ENP.

With the proposed plan, S-332B, C, and D pumped water when the upstream stage of S-176 was higher than 5.1 feet, NGVD. To maximize environmental benefits in some areas, the pump stations could operate at different stages. The operations study will address these issues.

8.6.4 Economic Evaluation Comments/Responses

a. Calculation on Rocky Glades Population

The initial estimate for displacement of people in the Rocky Glades Area used in the draft report was based upon tax roll information provided by Dade County. The information showed 15 structures classified as single family residential in the affected area. However it was not known at that time how many structures were abandoned after Hurricane Andrew or how many were simply adjoining structures such as sheds or utility living quarters. Multiplying 15 X 3.21 people per household yields the 50 person estimate that is stated to be the maximum amount of people displaced by land purchases in the Rocky Glades area. Subsequent field investigations have been conducted since the publication of the draft report. The Real Estate Appendix C will indicate that there are 4 homes in the affected area. Using 3.21 people per household the estimate of people will be revised to 13.

b. Purpose of Study

Project formulation and evaluation in the document has given equal weight to both environmental and flood control concerns. Although the objectives for the formulation were to only maintain existing flood control protection, the recommended plan actually increases flood control protection in the form of decreased flood durations to agricultural land owners east of C-111. Benefits shown for alternative 6A in Appendix E reflect this increased protection.

c. Agriculture Statistics in Rocky Glades Area

The acreage of effected land use shown in Section 6.8 and in Table 6.1 of the draft report have been underestimated. The corresponding text in Section 6.8 (Agriculture) and a revised Table 6.1 will be provided in the final report. Increase in acreages between the draft report and the final report are due to a more accurate transcription of information from the Modified Water Delivery GDM. Information describing the types of tree crops located in the Rocky Glades area will also be added to paragraph 7.

d. Flood Control for Areas West of Protection Levee

The authorized project was never designed to provide flood control protection west of L-31N. Productive acreage west of L-31N is considered to be incompatible with optimum stage regulation authorized by the original flood control project. Plan alternatives which worsen conditions over optimum stage levels in this area include the purchase of these lands as a project component. Therefore flood damage effects to this land use are not considered.

e. Community Cohesion

Two separable effects are expected to occur in the Frog Pond and Rocky Glades Area. Optimum water levels will be re-established in the area whether or not the plan alternative is implemented. Therefore decreases in Community Cohesion caused by this action are not project related. However, marginal increases above optimum stage in this area caused by the proposed alternative would cause somewhat decreased effects in Community Cohesion. Table 5-2 will be revised to show these worsened conditions. No adverse condition is expected for alternative 1 or alternative 9.

f. Displacement of Business and Displacement of Farms

Indirect impacts to business will be affected by removing the Frog Pond and Rocky Glades from production. However, the quantification of these losses is unknown at this time. In addition, these losses may be somewhat offset by the increased flood control protection provided to agribusiness east of C-111. Table 5-2 will be revised to show worsened conditions. No adverse condition is expected for alternative 1 or alternative 9.

g. Economic Impacts

Table 5-3 entitled "Effects Evaluation; Categories of Natural and Cultural Resources Effects..." is not intended to address the economic effects of alternative plans. Economic effects, including effects on businesses, farms and the regional economy are addressed in tables 5-2 and 5-4. The categories described in Table 5-3 encompass and are consistent with the concept of human environment as used in

NEPA and the appropriate portions of the NEPA regulations established by the Council on Environmental Quality (CEQ) in 40 CFR Parts 1500-1508.

h. Economic Evaluation

The annual benefit row shown in Table 5-4 pertains only to the National Economic Development (NED) account. Negative effects attributable to agricultural land purchases are accounted for in the NED account as a project cost and are displayed on an annual basis. The effect of increased project costs for flood control would be to reduce the net benefits to the project and reduce the corresponding benefit-to-cost (B/C) ratio of the flood control portion of the project. Effects upon accessory industries is a regional impact which has not been ascertained. However this impact is not part of the NED account. Negative impacts of alternative plans are identified in the Regional Economic Development (RED) account in table 5-4.

i. Agricultural Economic Impact Study

Detailed studies to quantify regional impacts on the agricultural economy were beyond the scope of the General Re-evaluation Report (GRR). Impacts are addressed in qualitative terms in tables 5-2 and 5-4, and an estimate of direct losses to agriculture associated with land purchases is discussed in Section 6.8.

j. NED Analysis

The Canal 111 basin which includes the Frog Pond and the Rocky Glades Area has been farmed for at least 30 years. The District has no evidence that these agricultural activities are "unsustainable". The gains in biological diversity expected with the project are discussed as environmental restoration benefits. Because these gains are accounted for as benefits, they are excluded from cost considerations to avoid double counting. Regional income losses prevented cannot be claimed as NED benefits without detailed studies to demonstrate that these losses would not be made up elsewhere in the national economy (as is generally the case). Regarding the assertions that project implementation will have beneficial effects on regional income for sportfishing and tourism, a causative link between the project and these sources of regional income has not been demonstrated. The linkage between project implementation and losses to regional agricultural income is readily apparent. Based on the best currently available information, it appears that alternatives 4, 6, and 6A would have overall negative impacts on regional economic development.

k. Flood Damage Susceptibility

The statement, "Unless lands are taken out of production for future environmental acquisitions, the flood damage susceptibility will remain the same.", will be deleted from the text.

l. Federal Responsibility to Homeowners

Federal responsibility to homeowners, workers and businesses of the region in recognized in the recommended plan in the form of positive flood control benefits to the area east of C-111. In addition, responsibility to mitigate for adverse effects is the basis for some of the land acquisitions for the recommended plan.

m. Federal Objectives

The flood control feature of the NED account is improved since flood damage prevention increases with the selected plan. Positive flood control benefits accrue to the area east of C-111 when the without and with project alternatives are evaluated at authorized stage levels. Although project costs for environmental project purposes have been determined, NED benefits attributable to environmental purchases have not been determined. Therefore, the effect upon the entire NED account is not known. All costs and benefits that have been computed for the GRR will be shown in the Environmental Impact Statement under NEPA. The Other Social Effects account (OSE) and Regional Economic Development accounts (RED) are displayed and compared with the NED account in section 5 in the main report. Negative effects attributable to agricultural land purchases are accounted for in the NED account. Lands purchased are a project cost and are displayed on an annual basis. The effect of increased project costs is to reduce the net benefits to the project and reduce the corresponding benefit-to-cost (B/C) ratio of the flood control portion of the project.

NED impacts have not been ignored. Flood control is an important project purpose. The NED plan is not identified in this report because the report objectives are slightly different than in traditional reports. The objective is not to maximize flood control protection but rather to re-instate the protection provided by the original project under changing land use conditions. However, overall flood protection will increase, indicated by positive flood control benefits, for the area east of C-111 with the recommended plan when both conditions are evaluated at optimum stage levels.

n. Preliminary Analysis of Annual Benefits and Costs

The objectives in this report are slightly different than in traditional reports. The flood control objective is to re-instate the protection provided by the original project under changing land use conditions. All plans evaluated include a flood control component to provide the stated protection. Therefore, the flood control component benefit-to-cost ratio for all plans is close to identical to the B/C ratio computed for alternative 1A. A dollar value has not been assigned to the environmental benefits for this project. To compare total benefit-to-cost ratios without including environmental benefits would be misleading.

o. Displacement of People, Businesses and Farms

The negative effects of alternative plans on regional employment and income (i.e., ripple effects), are identified in table 5-4. Detailed analyses to quantify the number of jobs lost were beyond the study scope. Losses to businesses, etc., are addressed in qualitative terms in tables 5-2 and 5-4. Direct revenue losses to agriculture are discussed in section 6.8.

p. Flawed Flood Damage Assessment

Generalized criticism of flood damage evaluation is noted. Topographic information for the Frog Pond was provided by Ghioto & Associates in 1988.

q. Seasonal Adjustments for Field Crops

Seasonal Adjustments for Field Crops, in Appendix E has been revised in the final report to show increased probabilities of flooding during the period November 1 to March 31. Cumulative percentages increase from 0% to 7%.

r. Root Zone Depth

As noted, effects of capillary action to draw water into the root zones on flood damage susceptibility were not considered. Increasing root depth susceptibility would have the net effect of increasing field crop potential damage without and with project conditions. Since benefits are measured as the difference between without and with project conditions, flood damages prevented for the area east of C-111 would increase with this assumption for all alternatives evaluated.

8.6.5 Real Estate Comments/Responses

a. Fair Market Value for Lands

Land required for the project will be appraised at the fair market value. This appraisal will value all real property including existing crops, fruit trees, irrigation systems, structures, etc., that will not be relocated. Eligibility for relocation benefits as stated in Public Law 91-646, Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended will be assessed.

b. Moving Costs

For the purposes of this planning report, the land values include crops and improvements currently on the property. There are four residences identified for Public Law 91-646 relocation payments which are discussed in Paragraph 7.2.2. and Appendix C, Real Estate Plan. There are no business relocation moving costs identified because the owners will be compensated for existing crops, fruit trees, irrigation systems, etc.

A real Estate Design Memorandum (REDM) will be prepared during the Planning, Engineering and Design phase. Additional relocations may be identified during this phase and will be included in the REDM.

c. Costs for appraisals

Additional appraisals will be covered by contingencies. The title work and environmental audits are included in the acquisition administrative costs.

8.7 PUBLIC MEETINGS

A public meeting was conducted during the draft report review period to provide all members of the public with an opportunity to better understand and discuss the results of the Corps' GRR. This meeting was held in Homestead, Florida on March 29, 1994 at the Homestead Senior High School. A transcript was made of the meeting and this will serve as the official record on the meeting. At the public meeting, background information on the study was presented and the recommended plan was described in detail. The public was then provided the opportunity to express their views on the GRR and to ask questions.

The meeting was attended by over 700 people. The speakers were divided into basically two groups, environmental groups in support for Florida Bay and the agricultural community requesting the use of a curtain wall to divide their land from the ENP.

In addition to the meeting, the SFWMD Florida Bay Subcommittee was briefed in December 1993 and again in February 1994, which provided the public with information concerning this study and afforded the public the opportunity to speak.

8.8 SUMMARY OF COMPLIANCE WITH APPLICABLE ENVIRONMENTAL REQUIREMENTS

1. Archeological and Historic Preservation Act, as amended. 16 U.S.C. 469 et seq., as amended by PL 96-515, December 12, 1980.

Full compliance. By letter dated March 21, 1994 the State Historic Preservation Officer concurred, pending on site surveys during detailed design phase.

2. Clean Air Act, as amended. 42 U.S.C. 7401 et seq.

Partial compliance at this time. Full compliance will be achieved through coordination of this integrated feasibility report and EIS with the Environmental Protection Agency, which will permit that agency to review and comment publicly on the environmental impacts of the alternatives, including the Recommended Plan.

3. Clean Water Act (Federal Water Pollution Control Act), as amended. 33 U.S.C. 1251 et seq. (PL 92-500).

Partial compliance at this time. Although this document meets the requirements of Section 404(r) of the Act (Annex B), a Section 401 State water quality certificate will be sought during the later preconstruction engineering and design phase.

4. Coastal Zone Management Act of 1972, as amended. 16 U.S.C. 1451 et seq.

The study is in compliance at this stage. A Federal consistency determination in accordance with 15 CFR 930 Subpart C is provided as Annex C. By letter dated April 29, 1994, the State found the draft GRR-EIS consistent with the State's Coastal Zone Management Plan and endorsed further planning and development of an operational plan.

5. Endangered Species Act of 1973, as amended. 16 U.S.C. 1531 et seq.

Full compliance at this time. The Corps of Engineers has determined that the alternative plans will not affect listed species nor their critical habitats. By letter of February 3, 1994, the Secretary of the Interior concurs with the Corps' determination, except for the Cape Sable sparrow. A USFWS Biological Opinion may be required for this species when operational plans are developed.

6. Estuary Protection Act. 16 U.S.C. 1221 et seq. (PL 9454, 3 August 1968).

Barnes Sound may be considered an estuary because it is subject to inflow from C-111. The flow is controlled and intermittent, however, and there is no true estuary in the study area. In the spirit of the Estuary Protection Act, however, this report is being submitted to the Secretary of the Interior for comment, including comment on the studied alternatives' effects on the lagoons and bays in the study area.

7. Federal Water Project Recreation Act, as amended. 16 U.S.C. 4601-12 et seq.

The study is in full compliance at this stage. Recreation planning and consideration will be continued during later stages of planning and design.

8. Fish and Wildlife Coordination Act, as amended. 16 U.S.C. 661 et seq.

The U.S. Fish and Wildlife Service and the Florida Game and Fresh Water Fish Commission have been cooperating agencies on the interagency planning team. They have participated in identification of environmental problems, formulation of alternatives, and assessment of impacts. Letters from the U.S. Department of the Interior Regional Environmental Officer are included with this report. Concurrence and support of the Department with the project purpose and the planning procedure are indicated in the letter dated February 3, 1994. The later letter, dated May 13, 1994, contains an expression of support from the Department for the adoption and expedited implementation of the recommended Plan 6A. Department of the Interior support for Plan 6A is contingent on the inclusion of (1) the extension of the water detention/retention area on a north-south alignment through the central portion of the Frog Pond, (2) a connector canal to convey water from L-31W to C-111 below S-175 and S-177, and (3) an increase in the size of the S-332E pump station and considered location of the C-111N spreader canal.

The DOI letter of May 13, 1994, states that the U.S. Fish and Wildlife Service will supply a Fish and Wildlife Coordination Act Report (CAR) upon receipt of the results of environmental investigations by the National Park Service. An interim CAR supporting the project was received on May 31, 1994 and is included in Annex D. In accordance with the Scope of Work between the Corps of Engineers and the National Park Service, peer reviewed scientific studies now underway will form the basis of the Secretary of the Interior's report to Congress as required by Sec. 2(b) of the Act.

9. Land and Water Conservation Fund Act of 1965, as amended. 16 U.S.C. 4601-4 et seq.

No properties affected by this act are involved in the recommended project area.

10. Marine Protection, Research, and Sanctuaries Act of 1972, as amended. 33 U.S.C. 1401 et seq.

Ocean disposal of dredged material is not proposed.

11. National Environmental Policy Act of 1969, as amended. 42 U.S.C. 4321 et seq. PL 91-190, as amended.

The study is in compliance at this time. Comments on the draft GRR-EIS by Federal, State and regional agencies having jurisdiction or relevant expertise,s by affected parties and the interested publics are included in this document.

12. National Historic Preservation Act of 1966, as amended. 16 U.S.C. 470 et seq., as amended by PL 102-575, 2 Nov 92.

Consideration of effects on historic resources are addressed in the body of the EIS, and comments have been received from the State Historic Preservation Officer.

13. Coastal Barrier Resources Act.

The study area is not in a designated CBRA unit.

14. Rivers and Harbors Appropriation Act of 1899.

The study is in full compliance. The studied work would not obstruct waters of the United States.

15. Watershed Protection and Flood Prevention Act of 1954, as amended.

This is not applicable to U.S. Army Corps of Engineers projects.

16. Wild and Scenic Rivers Act of 1968, as amended.

The study is in full compliance. No rivers designated under the Act are in the study area.

17. Executive Order 11988, Flood Plain Management.

The study is in full compliance. The considered alternatives support avoidance of development in the flood plain, continue to reduce hazards and risks associated with floods and to minimize the impact of floods on human safety, health and welfare, and restore and preserve the natural and beneficial values of the base flood plain.

18. Executive Order 11990, Protection of Wetlands.

The study is in full compliance. The nature of the project is that it involves work in wetlands, and no practicable alternative to working in wetlands exists. Losses and degradation to the beneficial values of wetlands are minimized, and such values are preserved and enhanced. The public has been involved in early planning.

19. Executive Order 12114, Environmental Effects Abroad of Major Federal Actions.

This executive order is not applicable to this study.

SECTION 9

RECOMMENDATIONS

I recommend that the Central and Southern Florida Project be modified to allow for improved water deliveries to Everglades National Park in accordance with the 1968 Flood Control Act. The total estimated cost of the recommended plan is $121,413,000. The estimated Federal (USACE) cost is $59,027,000 and the estimated non-Federal cost is $62,386,000.

The above recommendations are made with the provision that prior to project implementation, the non-Federal sponsor shall enter into a binding agreement with the Secretary of the Army to perform the following items of local cooperation as required in the 1968 Flood Control Act and modified by Executive Order:

a. Make a cash contribution of 20 percent of the contract price plus supervision and administration for all items of work to be provided by the Corps of Engineers, an amount presently estimated at $11,696,000 to be paid in a lump sum prior to start of construction or in installments prior to start of pertinent work items in accordance with construction schedules as required by the Chief of Engineers, the final allocation of costs to be make after the actual costs have been determined;

b. With appropriate jurisdiction, construct and thereafter maintain such canal facilities and other water control appurtenances as are necessary to realize the benefits from the improvements;

c. Provide without cost to the United States all lands, easements, and right-of way necessary for construction, operation and maintenance of the project, when and as required;

d. Assume the cost of construction of all non-Federal highway bridges, relocation of existing non-Federal highway bridges and alteration of utilities and other improvements except railroads, incident to construction of the project.

e. Hold and save the United States free from damages due to the construction, operation, and maintenance of the project works;

f. Participate in the National Flood Insurance Program and other applicable Federal flood plain management programs;

g. Provide guidance and leadership to prevent unwise future development in the flood plain;

h. Assume financial responsibility for all costs incurred in cleanup of hazardous materials located on project lands covered under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), for which no cost sharing credit shall be given, and operate, maintain, repair, replace, and rehabilitate the project in a manner so that liability will not arise under CERCLA;

i. Operate and maintain the pumping stations, levees, canals, and other appurtenant works herein, after completion of construction for flood control, navigation, and backpumping and delivery of water to Everglades National Park, the agricultural areas, and urban areas, in accordance with regulations approved by the Secretary of the Army. The Federal government, however, would reimburse local interests 60 percent of the annual pumping costs, including fuel, lubricants, proportional depreciation and repairs, and operating labor for all pump stations. All other operation and maintenance costs of the project will be borne by local interests.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Office of Management and Budget (OMB) as proposals for implementation funding. However, prior to transmittal to the OMB, the sponsor, the State, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

TERRENCE C. SALT
Colonel, Corps of Engineers
Commanding

SECTION 10

LIST OF PREPARERS

The people who were primarily responsible for contributing to preparing this Environmental Impact Statement are listed in Table 10-1.

Table 10-1

C-111
List of Preparers

NAME	DISCIPLINE/ EXPERTISE	EXPERIENCE	ROLE IN PREPARING DOCUMENT
Gerald L. Atmar	Biology	15 years environmental impact assessment, Corps of Engineers	Report-EIS preparation; review and supervision
Annon I. Bozeman, Jr.	Outdoor Recreation Planner	14 years recreation design, construction and development	Aesthetics and Recreation
Joseph Carroll	Biology	USFWS, Vero Beach	Fish and Wildlife coordination Act Report, Planning partners
Robert J. Fennema	Hydrologist	Everglades National Park	EIS preparation
Lewis I. Hornung	Civil Engineer	17 years water resources planning, Corps of Engineers	Report-EIS preparation: project management
Robert A. Johnson	Hydrologist	Everglades National Park	EIS preparation
Janet Ley	Biology	South Florida Water Management District	EIS preparation
James McAdams	Environmental Engineer	12 years water resources planning, Corps of Engineers	Water quality assessment
David L. McCullough	Archeology	12 years environmental and cultural resources assessment	Cultural Resources evaluation, coordination
John C. Ogden	Biology	Everglades National Park	EIS preparation; study manager for ENP
Susan D. Olson	Civil Engineer	South Florida Water Management District	EIS preparation; study manager for SFWMD
Stephen T. Sutterfield	Civil Engineer	12 years water resources planning, Corps of Engineers	Report-EIS preparation: study manager

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INDEX

ANNEX A

C-111

LETTERS RECEIVED IN RESPONSE TO THE DRAFT

GENERAL REEVALUATION REPORT

AND

ENVIRONMENTAL IMPACT STATEMENT

STATE OF FLORIDA
DEPARTMENT OF COMMUNITY AFFAIRS

2740 CENTERVIEW DRIVE • TALLAHASSEE, FLORIDA 32399-2100

LAWTON CHILES
Governor

LINDA LOOMIS SHELLEY
Secretary

April 29, 1994

Colonel Terrence Salt
U.S. Army Corps of Engineers
Post Office Box 4970
Jacksonville, Florida 32232-0019

Dear Colonel Salt:

RE: U.S. Army Corps of Engineers Draft Integrated General Re-evaluation Report (GRR) and Environmental Impact Statement (DEIS) on the Central and Southern Florida Project -Canal 111 (C-111) South Dade County, Florida
SAI: FL9403010133C

The State of Florida has completed its review of the draft Integrated General Reevaluation Report (GRR) and Environmental Impact Statement (DEIS) on the Central and Southern Florida Project - Canal 111 (C111), South Dade County, Florida. The GRR and DEIS have been reviewed in accordance with the requirements of the National Environmental Policy Act and the Coastal Zone Management Act of 1972, as amended.

During the state's review, we requested and received comments from the Departments of Environmental Protection, Transportation and State, the Florida Game and Fresh Water Fish Commission and the South Florida Water Management District which are incorporated herein by reference. Additionally, a meeting to discuss the project was held in West Palm Beach on April 20, 1994, which included representatives of the Corps, Governor's Office, Departments of Environmental Protection and Community Affairs, Game and Fresh Water Fish Commission, South Florida Water Management District and Dade County. Another meeting on the project was held on April 20 in Miami, which included representatives of the Corps, Governor's Office, Department of Environmental Protection, South Florida Water Management District, Dade County, agricultural interests of Dade County, the Nature Conservancy, National Audubon Society, Florida Audubon Society and Friends of the Everglades.

The State of Florida concurs with the Corps' determination that, of the alternatives presented in the draft GRR/EIS, alternative 6A is preferred. However, since its effectiveness in meeting environmental enhancement and flood protection goals will not be determined until further operational details, design evaluation and hydrologic modeling are completed, we request a thorough evaluation of the design modifications recommended by our reviewing agencies, as enclosed.

In addition to the enclosed comments made by our reviewing agencies, the State of Florida wishes to strongly emphasize our desire to further a plan which maximizes the restoration of natural water flows to the eastern and southern Everglades. We are particularly interested in eliminating the adverse effects of C-111 and urge that every effort be made to find an alternative to the continuation of fresh water discharge to Manatee Bay through lower C-111, specifically that: (1) the subdivided buffer strip be expanded, (2) the proposed C-111 spreader canal be moved north to align with an existing drainage ditch and extended under U.S. Highway 1; (3) the capacity of the pump S332E be increased for enhanced flood protection; and (4) the southern reach of C-111 be filled or plugged. We realize that a level of flood protection for Florida City and the surrounding areas must be maintained, and this recommendation assumes that the suggested alternative combined with an operating schedule for the entire C-111 basin can accomplish this objective. In any event, if C-111N is to be constructed, then it needs to be moved north to minimize the impacts on wetlands of dredging and filling.

Consideration and discussion of plans for managing lands to be acquired under this plan needs to be included. Land management plans need to be developed that will avoid the invasion of acquired lands by exotic species.

While the state is not advocating Alternative 9 - "Seepage Curtain Wall," the state believes that the potential benefits or risks of this proposal have not been adequately addressed.

In so far as this project is still in developmental stages and subject to modifications based on further Corps work and consideration of the comments contained in and attached to this letter, we find the draft GRR/EIS consistent with the Florida Coastal Management Program and the goals, policies, plans and objectives of the State of Florida. Furthermore, our final position will be based on the review of further plans, including the operating schedule for the project and modeling results which evaluate the modifications suggested above. Please provide the State Clearinghouse with any supplemental EIS, further project plans, reports and the final EIS for the state's review.

We appreciate the Corps' efforts to assist in the restoration of Everglades National Park and the priority that this project has been given. Your staff has been very cooperative in its willingness to meet and discuss the project. We look forward to working with the Corps on a plan to enhance the natural conditions of Everglades National Park and Florida Bay.

Very truly yours,

David Jordan, Jr.

Linda Loomis-Shelley
Secretary

LLS/ewr

Enclosures

cc: Virginia Wetherell, Department of Environmental Protection
Allan Egbert, Game and Fresh Water Fish Commission
Tilford Creel, South Florida Water Management District
George Percy, Department of State
Estus Whitfield, Executive Office of the Governor
Pamela McVety, Department of Environmental Protection
Bradley Hartman, Game and Fresh Water Fish Commission
Mike Ciscar, Department of Transportation

Florida Department of
Environmental Protection

Lawton Chiles
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Virginia B. Wetherell
Secretary

April 27, 1994

Estus Whitfield
Office of Planning and Budgeting
Executive Office of the Governor
The Capitol
Tallahassee, Florida 32399-0001

RE: Draft Integrated General Reevaluation Report and
Environmental Impact Statement (IGRREIS), Canal 111
SAI: FL9403010133C

Dear Mr. Whitfield:

Some of the comments provided by the Department on January 28, 1994, regarding the alternatives included in the C-111 Canal Preliminary Draft IGRREIS dated December 1993, are still pertinent to the most recent draft dated February, 1994. Several modifications previously suggested by the Department have been included in the recommended plan; however, other important issues have not been addressed. Additional comments are included to address the new alternatives presented in this draft.

As originally designed, the Central and Southern Florida Flood Control Project was never intended to provide flood protection for land west of the L-31N levee and the C-111 Canal. However, indirect drainage and flood protection have been provided through the lowering of adjacent canal levels. As a result, the ground water elevation has been reduced and ground water movement altered. The Rocky Glades ecosystem has been adversely impacted. Water deliveries to Everglades National Park (ENP) have at times had to be modified and even curtailed. Increased discharges to Manatee Bay and Barnes Sound have resulted in significant environmental deterioration in these waterbodies. The combined result of all these effects has been a loss of adequate quality, quantity, and timing of fresh water flow to Florida Bay. The Department can only support modifications to the C-111 project which will protect Manatee Bay and Barnes Sound and result in significant improvements to the habitat and water quality of the Everglades and Florida Bay.

The Corps' preferred Alternative 6A does not go far enough toward accomplishing this objective. However, we believe that this aternative could be improved significantly with further modification and improvement (cf. enclosed figure). Specifically, a 500 cfs pump (S-332E) should be located on the C-111E Canal and discharge to a spreader canal which extends east at the north end of the C-109 and C-110 Canals and passes under U. S. Highway 1. This feature would increase the ability to disperse water in a more natural manner into existing wetland areas. Filling of the C-109 and C-110 Canals would prevent the short-circuiting of marsh sheet flow.

The spreader canal proposed in Alternative 6A would be constructed through undisturbed, high quality marshes. About 2000 feet north of the junction of the C-111 and C-111E Canals, an existing ditch extends eastward from the C-111E Canal to U.S. Highway 1. Instead of crossing an undisturbed marsh, the canal should be constructed through this previously disturbed area. If flow requirements make it necessary to connect the spreader canal directly to the C-111 Canal, an extension westward from the C111-E Canal to the C-111 Canal at the more northern location would disturb considerably less wetlands than the proposed location.

With the 500 cfs capacity of S-332E Pump Station available to provide flood protection, the C-111 Canal south of the pump station should be filled. Back-filling the C-111 Canal would be a very great and long awaited environmental accomplishment. This section of the project cuts through the publicly owned Southern Glades which should be restored to a natural condition. Reestablishing sheet flow through this area will benefit the marshes adjacent to existing canals and in the panhandle of the ENP and provide ample opportunity for water quality enhancement. A greater volume of fresh water discharge to Florida Bay will result and dry season ground water drainage to the canal along U.S. Highway 1 will be halted. The Outstanding Florida Waters and Aquatic Preserves of both Manatee Bay and Barnes Sound would be spared the periodic devastation caused by large scale discharges down the C-111 Canal and through the S-197 Structure. If modeling suggests that backfilling the entire length of the C-111 Canal would retard ground water flow, we recommend placing plugs downstream of each of the nine culverts in C-111 to ensure that surface and ground water flows are not diverted eastward. The C-111 Canal can be plugged using material obtained from degrading the spoil mounds south of the canal.

An important environmental function may currently be provided by the spoil mound and culvert system on the northeast bank of the lower C-111 Canal. Caution should be used when considering alterations to this spoil levee. A healthy and functional biological community adapted to current water levels exists in the area north of the C-111 Canal and west of U.S. Highway 1. While providing excellent habitat, this area also serves as an important water storage area. It is possible that the water levels which currently exist in this storage area are very similar to those which existed before the natural hydrology of south Florida was destroyed. This is one of the few remaining areas which stores excess water during the wet season, moderates large scale discharges from the canal system, and helps maintain ground water levels and flows into the dry season. If C-111 Canal is filled, the northern levee should be preserved. Sheetflow to the south can be provided by operating the control culverts that exist in the levee on the north side of the C-111 Canal.

The plan should include extensions of the sub-divided buffer strip to the north to include the discharge from the S-332A Pump and to the south to the southern end of the Frog Pond. Pump station S-332 should be relocated to the west bank of the C-111 Canal with discharge via a lined canal to the extended sub-divided buffer strip. Culverts in the L-31W levee would provide a widely distributed discharge to the headwaters of Taylor Slough. A new control structure should be constructed in the south end of the reservoir which would discharge water from the south end of the Frog Pond back into the C-111 Canal.

As seepage from wetlands west of the canal system is reduced, the dilution of agricultural and urban pollutants will also be reduced. The final project design must include features which will allow all discharges from the project to the Everglades Protection Area to meet the water quality standards which have been developed for that area. The modifications outlined above would provide water quality treatment in the detention/retention zone for all L-31N and C-111 Canal water discharging to ENP. In addition, extending the sub-divided buffer strip would also maximize the temporary storage of excess flood waters, raise additional ground water levels adjacent to ENP and provide additional sheet flow distribution for water discharging to ENP. Ground water levels would be raised in an area that historically provided an important storage function. Seepage from the storage areas would help maintain Everglades and Taylor Slough water levels into the dry season.

Increased ground water levels would also be beneficial to the ecologically important biological community of the Rocky Glades. This community played an important role as a major food source for the Everglades' animal population. During the beginning of the dry season when water levels were still high in other areas of the Everglades, declining ground water levels in the Rocky Glades concentrated food in the rocky depressions. This declining ground water level also helped to provide water to, and extend the hydroperiod of, the Everglades. Formerly, an abundance of varied feeding areas available at different times during the year provided great stability to the Everglades ecosystem.

A major deficiency of the draft IGRREIS is that it does not include operational details for the system after modification. Without operational details, the potential benefits from structural modifications cannot be fully understood and no definitive conclusions of environmental consequences can be drawn. For instance, what ground water and water control elevations will govern operation of the various structures and canals? How will these elevations vary between the wet and dry seasons and during the planting and growing season? Will ground water elevations anywhere in the basin trigger the shut down of the Everglades water delivery system? These are important questions which will ultimately determine the final success and environmental impact of project modifications. We are particularly concerned with this point since the Corps' proposed Alternative 6A would allow discharge through C-111 Canal to Manatee Bay under some conditions.

Water and environmental quality are rapidly deteriorating in the Everglades and Florida Bay ecosystems. It is essential to turn this trend around as soon as possible with aggressive restoration efforts, of which the modifications to the C-111 system are critical components. Although Alternative 6A is the best option presented in the IGRREIS, it needs further modification to achieve the necessary results discussed in this and our two previous comment letters. Since the environmental impacts of Alternative 6A will not be fully understood until future design and hydrologic modeling are completed, the project design will be reevaluated in a future supplement to the EIS. The Corps has stated that the final design of Alternative 6A will be determined by this future analysis.

Since this alternative can be modified in the future, we do not object to proceeding with completion of the final EIS. Based on the information available at this time, we do not object to the project under the federal consistency provisions of the Florida Coastal Management Program. We will reevaluate the consistency of the project when the EIS is supplemented to document environmental impacts based on completion of further design and modeling. Our consistency position will be based on an adequate evaluation of Alternative 6A with the following modifications:

*Backfill or plug the C-111 Canal south of S-332E, increase pump capacity to 500 cfs, and extend the C-111 spreader canal under U.S. Highway 1;

*Provide water quality treatment in a detention/retention zone for all water discharging to Everglades National Park and other state waters;

*Extend the sub-divided buffer strip north to include the discharge from the S-332A pump and south to the southern end of the Frog Pond;

*Relocate pump station S-332 to the west bank of the C-111 canal with discharge via a lined canal to a detention/retention zone in the extended sub-divided buffer strip;

*Relocate the proposed southern spreader canal further to the north;

*Purchase the agricultural lands west of L-31N and C-111.

We anticipate that the Corps will evaluate and model an alternative with these features in the supplement to the IGGREIS. A comparison can then be made between this option and Alternative 6A as it is presented in the draft IGRREIS.

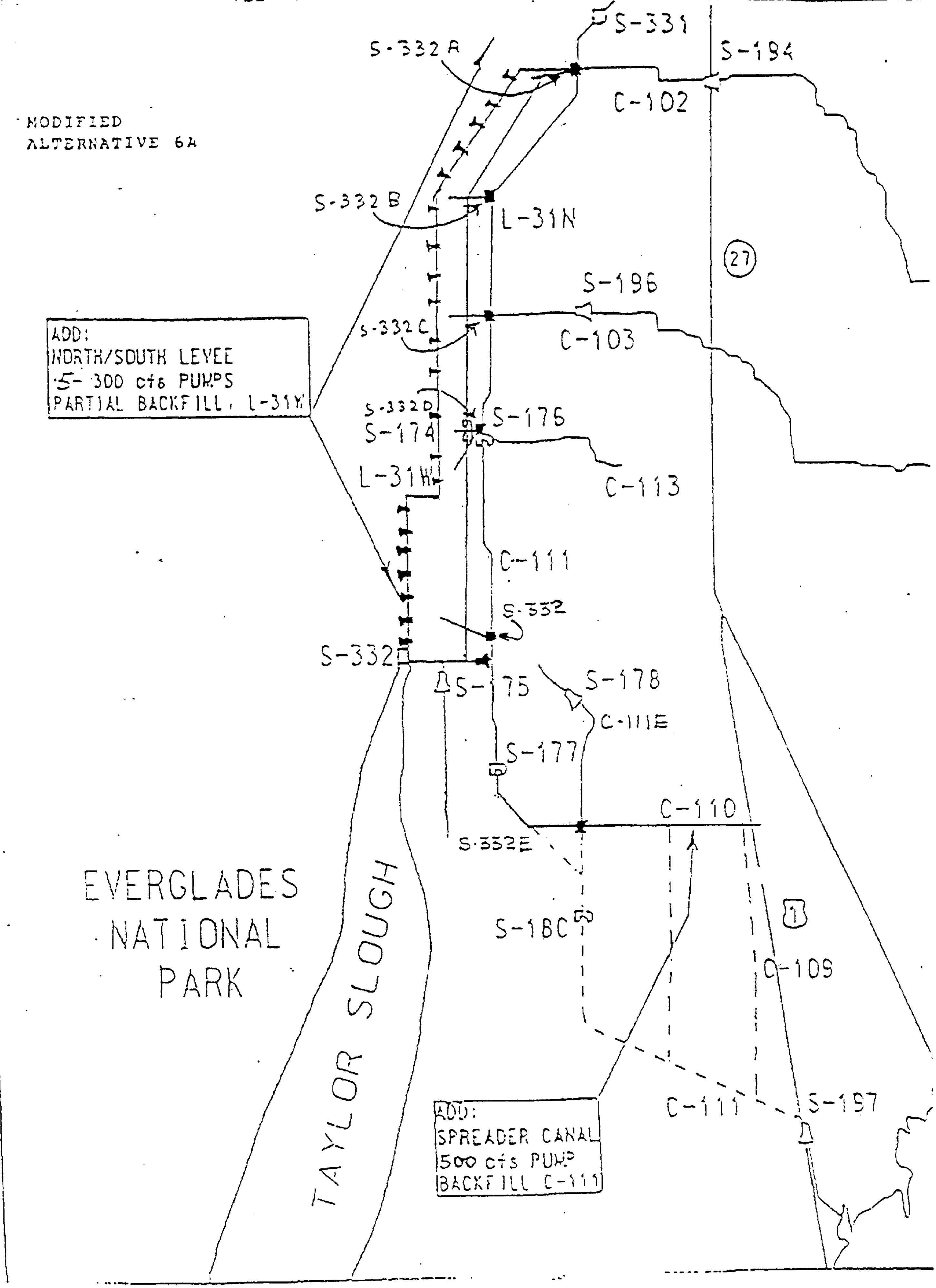
We appreciate this opportunity to comment on this important project. My staff is available to continue discussions with the Corps on developing an acceptable project. If there are any questions regarding the technical comments in this letter, please contact Herb Zebuth at (407)433-2650.

Sincerely,

Pamela P. McVety

Pamela P. McVety
Chief, Office of Intergovernmental Programs

VBW/hz
Enclosure
cc: Virginia B. Wetherell
Mary E.S. Williams
Ed Irby
Frank Nearhoof
George Baragona
John Abendroth
Greg Brock
Charles Knight
Frank Votra
Herb Zebuth



MODIFIED
ALTERNATIVE 6A
S-331
S-194
S-332 A
C-102
S-332 B
L-31N
27
S-196
S-332 C
C-103
ADD:
NORTH/SOUTH LEVEE
5- 300 cfs PUMPS
PARTIAL BACKFILL, L-31W
S-332D
S-176
S-174
L-31W
C-113
C-111
S-332
S-332
S-175
S-178
C-111E
S-177
C-110
S-332E
EVERGLADES
NATIONAL
PARK
TAYLOR SLOUGH
S-18C
1
C-109
ADD:
SPREADER CANAL
500 cfs PUMP
BACKFILL C-111
C-111
S-197

FLORIDA GAME AND FRESH WATER FISH COMMISSION

MRS. GILBERT W. HUMPHREY, Miccosukee | JOE MARLIN HILLIARD, Clewiston | J. BEN ROWE, Gainesville | JULIE K. MORRIS, Sarasota | QUINTON L. HEDGEPETH, DDS, Miami

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620 South Meridian Street
Tallahassee, FL 32399-1600
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April 4, 1994

APR 8 1994

Ms. Janice L. Hatter, Director
Florida State Clearinghouse
Executive Office of the Governor
Office of Planning and Budgeting
The Capitol
Tallahassee, Florida 32399-0001

RE: SAI #FL9403010133C, Canal-111 Draft General Reevaluation Report (GRR) and Environmental Impact Statement, Dade County

Dear Ms. Hatter:

The Office of Environmental Services of the Florida Game and Fresh Water Fish Commission has reviewed the referenced document, and offers the following comments.

Canal-111 (C-111) is part of the comprehensive Central and Southern Florida Flood Control Project (C&SF) authorized by the Flood Control Act of 30 June 1948. The purpose of the C-111 study is to develop a system of structures to aid in the restoration of the C-111 basin and the ecosystems of Everglades National Park (ENP). The 1989 Everglades National Park and Protection Act authorized the construction of modifications to the C&SF project to attempt to restore flows to ENP and to recreate a system more closely mimicking that which historically occurred. Guidelines established to aid in the formulation and evaluation of alternatives included the restoration of historic hydrologic conditions in the C-111 basin, protection of natural values associated with Everglades National Park, elimination of harmful freshwater flows into Manatee Bay/Barnes Sound, and the maintenance of flood protection for the C-111 basin.

Hydrological and biological evaluations were conducted and analyzed for seven of nine proposed structural alternatives. The predicted conditions for each of the alternatives were compared to modern historic conditions. Hydrological analysis required the development of a hydrohabitat model which incorporated the expanse of area that would receive more or less water in appropriate time frames and the degree of restoration of the historic hydrology in which the marl soil habitat was formed and maintained. For the biological evaluation, a species compatibility index was developed to compare the proposed effects of the alternatives on eight species or species assemblages including the wood stork, roseate spoonbill, Cape Sable seaside sparrow, American alligator, freshwater fishes in Taylor Slough, freshwater fishes in marl prairies, estuarine fishes, and emergent aquatic plants.

Three alternatives were added to the GRR after the release of the Preliminary Draft in December 1993. One alternative (Alternative 9) was supplied by the agricultural community, one by Everglades National Park (Alternative 8), and one by the U.S. Army Corps of Engineers (ACOE) (Alternative 6A). After review, Alternative 9 was determined to be economically infeasible and was dropped from consideration. Review of Alternative 8 showed that, conceptually, it offered more environmental advantages than any prior alternatives. The restoration of stages in the headwaters and upper portions of Taylor Slough would be the main benefit derived from Alternative 8. This would be accomplished by creation of a large buffer strip along the ENP boundary, from Tamiami Trail to the Frog Pond, including the 8.5-square-mile "residential" area. Water would be pumped from the L-31N into the buffer strip, allowing the maintenance of higher water levels along the ENP boundary. Additionally, the lower portion of the C-111 would be backfilled and a spreader canal with a 500-cfs pump station would be constructed to discharge water into the east/west spreader canal lands. The C-109 and C-110 would be eliminated.

Due to the advantages offered by Alternative 8, the ACOE incorporated some of its features into Alternative 6 and called it Alternative 6A. Similar to Alternative 8, Alternative 6A would create a levee, west of the L-31N from C-102 south through the Frog Pond. The area between the levee and the canal would serve as a buffer zone between the agricultural community to the east, and a detention/retention zone to the west. This detention/retention zone would be created by constructing a second levee west of the first levee. Four pump stations would be designed to pump canal water across the buffer zone to the retention/detention area, via lined canals. Twenty-four, 36-inch culverts and an overflow spillway would be constructed along the western levee of the detention/retention area. Similar to Alternative 6, a new canal with a 50-cfs pump (the spreader canal) would be added between the S-332E and US Highway 1, and would provide eastern conveyance across C-109 and C-110. Canal-109 and C-110 would be plugged. Spoil mounds south the C-111 would be degraded.

Of these alternatives, the U.S. Army Corps of Engineers has chosen Alternative 6A as the recommended plan. The objective of Alternative 6A is to restore stages and increase water levels in the headwaters and upper portions of Taylor Slough. The use of the retention/detention area would allow maintenance of higher water levels within the Rocky Glades and northern Taylor Slough. This would reduce seepage loss from Taylor Slough back into the canal and would aid in the treatment of stormwater runoff prior to release into ENP. The retention/detention area could be used to temporarily retain water, therefore allowing water to be released into the Taylor Slough during the appropriate time periods.

Based on review of the proposed alternatives, we believe that Alternative 6A, while a great improvement over the present day system, lacks the structural components necessary to move towards restoration of the lower C-111 basin. The report states that preliminary data developed at the South Florida Water Management District showed that backfilling C-111 caused a reduction in water moved to lands south of the lower section of C-111. This argument was used as justification for retaining C-111; however, without an operational change to bring additional water to the lower C-111 basin, to compensate for water diverted to Taylor Slough, environmental impacts cannot be properly determined. Operational and water supply options need to be developed to determine the potential ecological benefits of the proposed alternatives. We believe that plans which include: (1) backfilling C-111, (2) construction of a spreader canal with a large pump station (per Alternatives 4 and 8), (3) the functional elimination of C-109 and C-110, and (4) changing the operational criteria to allow for increases in overall flows into the system during specified periods, would provide the greatest ecological benefit by restoring sheetflow in the lower basin, and eliminating the capacity to release harmful, freshwater discharges into the estuary through S-197. Furthermore, we believe that the use of a spreader canal and large pump station, in addition to the redirection of S-18C discharges to the pumps proposed to deliver water to the detention/retention basins, would provide an effective method for flood control of developed lands in the region and would eliminate the need for the C-111.

Sincerely,

Bradley J. Hartman, Director
Office of Environmental Services

BJH/MS/rs
ENV 1-3-2
c111grr.sai
cc: Mr. A.J. Salem, Chief
Planning Division
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0012

Mr. David Ferrell
U.S. Fish and Wildlife Service
P.O. Box 2676
Vero Beach, Florida 32961-2676

FLORIDA DEPARTMENT OF STATE
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March 21, 1994

Ms. Janice L. Hatter, Director
State Clearinghouse
Executive Office of the Governor
Room 1603, The Capitol
Tallahassee, Florida 32399-0001

In Reply Refer To:
Denise M. Breit
Historic Sites
Specialist
(904) 487-2333
Project File No. 940727

RE: Cultural Resource Assessment Request
SAI# FL9403010133C
Central and Southern Florida Project - Canal 111 (C-111)
Dade County, Florida

Dear Ms. Hatter:

In accordance with the provisions of Florida's Coastal Zone Management Act and Chapter 267, Florida Statutes, as well as the procedures contained in 36 C.F.R., Part 800 ("Protection of Historic Properties"), we have reviewed the referenced project(s) for possible impact to historic properties listed, or eligible for listing, in the National Register of Historic Places, or otherwise of historical or architectural value.

A review of the document indicates that a survey will be performed per our recommendations of January 20, 1994 (SAI# FL9401051559C). Therefore, as long as this condition is met and project impacts to any identified significant historic properties are appropriately avoided, minimized, or mitigated, the proposed project will have no adverse effect on cultural resources listed, or eligible for listing, in the National Register, or otherwise of historical or architectural value.

If you have any questions concerning our comments, please do not hesitate to contact us. Your interest in protecting Florida's historic properties is appreciated.

Sincerely,

Laura A. Kammerer
for
George W. Percy, Director
Division of Historical Resources
and
State Historic Preservation Officer

GWP/Bdb
xc: Jasmine Raffington, FCMP-DCA

South Florida Water Management District

3301 Gun Club Road • P.O. Box 24680 • West Palm Beach, FL 33416-4680 • (407) 686-8800 • FL WATS 1-800-432-2045

PRO EVR

April 29, 1994

Colonel Terrence C. Salt, District Engineer
U.S. Army Corps of Engineers
Jacksonville District
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Colonel ~~Salt:~~ Rock

Attached is a summary of our staff comments regarding the Draft of the C-111 GRR. We at the District recognize and appreciate the hard work and dedication of Corps staff in meeting the accelerated schedule for this project. We also support your decision to proceed with the approval process within the Corps now, and to continue to revise the design in the next phase of the process. At the same time, we recognize there are major issues facing all of us in moving ahead on the C-111 project. We understand the importance of reaching consensus on a cost sharing recommendation within the next two weeks, and we pledge to work together with you to find something we can both support.

Based on comments from our staff and others concerned with C-111, a variety of technical issues need further investigation and refinement during future detail design studies. These issues involve design elements, real estate requirements, flood control benefits, and consensus on flow distribution patterns in the lower C-111 basin.

Be assured that the District is committed to working closely with the Corps and Everglades National Park in addressing these issues. We are encouraged by the progress made thus far, and are eager to play our part in addressing the needs of Taylor Slough, Florida Bay, and south Dade County.

Thank you for your help and continuing support with the C-111 effort.

Sincerely,

Til

Tilford C. Creel
Executive Director

attachment
c: Estus Whitfield, Governor's Office
Governing Board Members
Richard Ring, ENP

END

C-111 General Re-evaluation Report

Staff Review

APRIL 5, 1994

OVERVIEW

The Operations and Maintenance Department expressed some concerns regarding baseline assumptions built into the report. Cross sections given are pre-South Dade Conveyance system, and don't reflect existing configurations. Possible implications arise in that we really don't know how this alternative will reflect flows in the current configuration. Further, we don't know whether drawings or modeling are correct. This requires some clarification.

Use of optimum water levels in Table 2-1 are at issue. Model results indicating an improvement in flood control show an improvement only over this theoretical scenario. Cost/benefit decisions made on this basis could be misleading. We recommend adding a statement in Section 3.1 that addresses this. We further recommend additional model runs, utilizing current levels to evaluate the true flood benefits of the Alternative selected.

Given current difficulties in deriving an operational plan for limited test areas, we encourage early and earnest efforts to address an operating plan for this project.

Concerns have been expressed by our Planning Department that proposed construction activities will have substantial impacts on large areas of wetlands, especially during the period of construction. It is likely that these disturbed areas may take a long time to recover. These areas need to be protected to prevent invasion by exotic species. A potential mitigation for these impacts may come from conversion of Frog Pond agricultural lands to wetlands, and probable improved water deliveries to the southern glades wetlands of the proposed C-111N canal. To this end, the District would like to see some additional information included in the final design phase that details monitoring, restoration and management plans for the Frog Pond, Rocky Glades and southern C-111 areas.

Acquisition of agricultural "in-holdings" west of C-111 and L-31N is not stated as a defined objective of the GRR. The acquisition of those lands should therefore be subject to economic comparison with alternative means of accomplishing the objectives of the project.

There is no quantitative indication of the extent to which S-197 discharges will be reduced or eliminated by this plan. Such an analysis should be included.

Discussions regarding water quality are not included in this report. A basic analysis of the suitability of direct discharge of water from these adjacent lands to ENP needs to be considered.

INTRODUCTION

A question arose regarding the inclusion of River Basin Monetary Authorization & Miscellaneous Civil Works Amendments Act of 1970 as justification for this report. The act references a number of canals with designations unfamiliar to this group. What happened to these canals? If this Act is mentioned, care should be taken to correlate authorization with reality.

The Interim Plan specifics should be included in Section 1, in addition to current language. This could be used as an introduction to current canal configurations.

The Corps needs to update the Everglades SWIM section to reflect the passage of the Everglades Forever Act (Section 373.4592 FS).

Section 1.6.7 re: Hole in the Donut restoration. Was any incorporation made in the model to take the raised elevation of the eastern Frog Pond into consideration?

EXISTING CONDITION/AFFECTED ENVIRONMENT

Section 2 should be rewritten. There is no flow to it; the information is poorly organized and section 2.4.8 is technically inaccurate. It appears that most of the information came from the Everglades SWIM Plan. District staff would be willing to assist in this re-write.

On pages 2-10 to 2-11, statements are made concerning levels and sources of phosphorus and mercury in the Everglades that need some scientific basis. There are also some literature citations in the text with no follow-up description of the source in the "Sources Cited..." section, such as "FWS, 1991" on p. 2-15; "W.E. Odum et al, 1982" on p. 2-18; and the references cited in the reptiles section on p. 2-20.

FUTURE 'WITHOUT PROJECT' CONDITION

Section 3.2 references the inclusion of Modified Water Deliveries in the future "without project" condition. It indicates that an operational plan is part of MWD. This is not accurate, since there is no consensus on an operating plan for MWD.

Section 3.5 Land Use, 4th paragraph: needs to be rewritten. It is not clear what connection exists between a return to design criteria and the heading "future, without project" condition. Does this imply that if there is no GRR, there would automatically be a return to design optimum? This needs clarification.

Section 3.8, 3rd paragraph: should be eliminated, with suggested language included:

In Manatee Bay, Barnes Sound and Florida Bay, cycles of unnatural salinity conditions will likely continue. Discharges of large flow volumes to coastal receiving waters will occur within short time periods following major storms. This will result in significant swings in salinity, from 0 to levels well in excess of seawater salinity. The impact on the area biota will continue to be significantly negative.

Omit the 2nd Section 3.

PROBLEMS AND OPPORTUNITIES

Section 4.1, 3rd paragraph: question accuracy of sentence, "These flows are collected in the canals and are discharged, for the most part, to the east to Biscayne Bay." The Corps needs to look at the latest water budgets (either from ENP or the District) to discern levels flowing south versus east.

Section 4.1, 6th paragraph: The Corps needs to cite a reference for the values given for agricultural flood damage.

Section 4.3.2, 5th paragraph: The sentence, "By the late 1960's and early 1970's, construction of the L-31N, L-31W, and C-111 canal systems reached completion, and the optimum canal operational stages were lowered in response to expanding agricultural and urban development into the lower lying..." . We question the validity of this statement. The Corps needs to evaluate this statement, and consider if this is in fact the rationale for lowering these operational stages. If it is not, this may not be an appropriate cite for this document. It is also in conflict with recent statements made by the Corps in litigation. Definitely needs clarification.

FORMULATION OF ALTERNATIVE PLANS GENERAL RE-EVALUATION REPORT

Section 5.2.1 Restoration of Historic Hydrologic Conditions, 2nd sentence: should address why water quality is not considered in this report.

Section 5.2.3: No information is included in this section. We've recommended some (reference Section 3.8, 3rd paragraph above).

Section 5.5.1(a) Omit the word "natural". Staff asserts this statement may be true some of the time (during the wet season), but cannot be used as a general statement.

Section 5.5.1: We question whether the criteria suggested equate to "operational flexibility". We interpret that phase to mean the ability to balance all priorities for this plan, including the need to maintain flood protection. There is no mention of any flood protection features in items a-h. Better to define this section as "environmental factors".

Section 5.5.3 Environmental Benefits: typo, p.5-7, first sentence: "demonstration" should be "demonstrate".

Section 5.6 Alternatives: recommend moving this section into the Appendix.

Section 5.6.4.8 Alternative 6, last full paragraph: pump station designated S-332C should be S-332B.

Section 5.6.4.10, Alternative 9, 2nd paragraph: need to relook at environmental effects of curtain wall, and potential impacts on the aquifer and timing & distribution of flows along Everglades eastern wetland area.

Section 5.6.4.11 Alternative 6A: next to last sentence states that "project objectives of restoring natural timing, location...would be addressed by these features." We could find no evidence in your subsequent analyses that the timing of water deliveries was analyzed. Although the modeling runs indicate anticipated water levels and durations, they do not indicate the seasonal distribution of water. This is an issue of equal importance to the amount of water. There is no detailed analysis of the water quality effects of this plan. Presumably operational details will be developed and made explicit during the PED process. Without such details, it is not possible to make a full evaluation of the various alternatives. Second paragraph, last sentence: please reword to the following.

> "A concrete lined canal will be connected to the outlet side and discharge 1/2 mile west through the new S-332D tieback levee into the detention/retention zone."

Figure 5-23 indicates that a new, 1000 foot bridge will be required to replace the existing bridge across Taylor Slough. There is no basis for determining this bridge length. Where did the 1000 foot length come from? Is it necessary to be that long?

{We need additional detail regarding S-332 D pump station discharge: how will it work; general design concept}.

Section 5.10.1 Marl Soil Ecosystem Criteria: on pp. 5-51 and following, we agree that these are suitable conditions for the formation of marl soils, based on Tabb's work, and thus represent a reasonable performance measure. From that point on, the analysis was not very clear. Most of the marl model discussion on the bottom of p. 5-51 and the top of p. 5-53 was very awkward and hard to follow. Likewise, the continuing discussion on pp. 5-53 and 5-55 of Hydrohabitat Index was very confusing. Perhaps it would be clearer if the report included sample calculations showing how some of the actual numbers in Table 56 were derived. pg. 5-53 1st sentence: Section 2.5 is supposed to be marl measurements. Section 2.5 is actually population. Need to find it (we couldn't) and rename appropriate section, or delete that reference.

Section 5.14 Evaluation of Alternative Plans: this paragraph references Section 5.5. Section 5.2 names a separate group of objectives. How do these fit together? Which objectives are driving this process? This needs to be clarified. Recommend clarifying first sentence of Section 5.5 so the reader can better understand how the two sets of objectives are aligned. The two tables (5.8 and 5.9) do not help. Which of the two tables drove the process of choosing the best alternative? We recommend additional words to clarify and answer this question.

Results of hydrological assessment model runs (Figs. 5-26 to 5-36 and Tables 5-10 and 5-11) appear to be based on only one year of data (1976 - 1977). Given the wide variability of S. Florida rainfall, it seems risky to extrapolate very far from this result. Is this an average year?

ENVIRONMENTAL EFFECTS OF RECOMMENDED PLAN

Section 6.6 Water Quality. Again, concerns regarding water quality exist, and we think they should be addressed in this document in much more detail than what is covered in this paragraph.

Section 6.10, p. 6-7, 4th paragraph: Question re: calculation on Rocky Glades population. How do we get from 15 to 50, if 5 households contain 3.2 persons per? Either go with macro estimate, or change number to 16.

RECOMMENDED PLAN

Section 7.1.2 Pump Stations: there is no basis defined for sizing of the pumps (4 @300 cfs = 1200 cfs). Please define the process used to size these pumps.

Section 7.1.2.4, S-332D: Staff needs to understand how pump station discharges flow through the levee "toward" ENP. Is it through the retention/detention area, or directly to the Park? How wide is the top of S-332D? (Operations & Maintenance staff need to have this information to effectively comment from their perspective).

Section 7.1.2.5, S-332E: there is no definition of the basis for selecting 50 cfs capacity of S-332E.

Section 7.1.3.1 Levee 31-W tieback: L-31W tieback goes north to S-332B instead of S-332D (typo on page 7-5). L-31W indicates a levee crown width of 15 feet. District requires at least 18 feet of levee crown width for maintenance purposes (vehicle and equipment access needs). As it pertains to the section of the tieback north of S-176: there is no specific functionl criteria defined for the retention/detention area. It would appear that the retention/detention area is unlikely to have any real influence over the timing of flows into ENP, given its size, and hydraulic gradients involved. With respect to the section of the tieback from S-176 south to S-175: its function appears to be to define a buffer zone, in this case about 1 mile in width. It would appear to have a sole benefit in reduction of seepage inflows, in this case to the C-111 canal. Is this its purpose? If so, is this the most cost effective means to accomplish that end?

Section 7.1.3.2 S-332D Tieback Levee: The function of the levee appears to serve as a "buffer" between the retention/detention area and L-31N. Staff is concerned that seepage rates in the L-31N borrow canal will be significantly impacted by this tieback levee. To that end, this report does not quantitatively address either absolute or differential seepage rates of inflow to L-31N.

Section 7.1.3.7 Eastern Spreader Canal (C-111N): construction of C-111N includes placement of the spoil as a mound on the north bank of the spreader canal. This would appear to interrupt drainage from areas north of C-111N. What will be the impact on upstream properties? This is a question must be addressed. Extension of C-111N across U.S. 1 to provide water supply to "Model Lands" between US 1 & Card Sound road would appear reasonable, but is not included in the project as it is "outside authorization". It would seem reasonable to consider this for the future. Culverts across US 1 are still an issue, requiring additional discussion with DOT prior to implementation of either project.

Section 7.2.1, p.7-7: Need to replace or delete the last sentence of the first paragraph with new text. This sentence seems to contradict the preceding sentences in the paragraph, regarding the interest that needs to be acquired. We assume that the "buffer lands" referred to in the last sentence are the eastern portion of the Rocky Glades, but this is not totally clear.

Section 7.2.2, p. 7-8: There is no discussion of the moving cost payments that may be payable to the residents within the acquisition area. This should be addressed along with some discussion about the obligation to pay for any business relocation moving costs (i.e. moving fruit trees and irrigation system components from tropical fruit groves).

Section 7.3 Monitoring: the overall monitoring plan is very cursory in nature. This needs to be enhanced. The District will cooperate as part of this enhancement effort. Gathering data will be important for future project iterations.

PUBLIC INVOLVEMENT, REVIEW AND CONSULTATION

Section 8.5 Summary of Compliance with Environmental Regulations: Fish & Wildlife Coordination Act, as amended, #8, last sentence. "These subjects are discussed in Section 7.4." They are not discussed in Section 7.4. Should be Section 7.3.

RECOMMENDATIONS

LIST OF PREPARERS

Appendix C, section 7-b, p. C-5: Need to capitalize word "total" in next to last sentence.

Appendix C, section 9. Need to add discussion of residential and business moving costs.

Appendix C, section 10: We are required to do two appraisals when the subject property is valued at more than $500 k. Thus, the number of appraisals that the District will have to do to acquire 300 parcels will be more than 300, given that some portion of the parcels will be valued in excess of $500 k. The Corps should be able to make a reasonable guess as to how many parcels are large enough to require two appraisals. There should also be a discussion about the costs associated with doing title work/obtaining title insurance and environmental audits.

FLORIDA DEPARTMENT OF TRANSPORTATION

LAWTON CHILES
GOVERNOR

BEN G. WATTS
SECRETARY

MEMORANDUM

DATE: March 14th, 1994

TO: Todd Leachman, Planning

FROM: Mike Ciscar, Senior Project Manager

COPIES: John Martinez, Barbara Bernier, File

SUBJECT: **COMMENTS ON C-111 DRAFT GRR/EIS**
Work Program Item Numbers: 6116800; -6801; -3533; -4033
State Project Numbers: 90060-1501; -1585;
87010-1509; -1501
Federal-aid Project Numbers: SA-485-1(138); SN-485-1(140);
F-485-2(62); SE-485-2(71)
SR-5/US-1 South
From: Abaco Road, on Key Largo
To: Card Sound Road, just south of Florida City
Counties: Monroe & Dade

This is to provide you with my comments on the subject document.

The extent of my review was only to ascertain what impacts, if any, the US Army Corps of Engineer's (ACOE's) plans would have on the US-1 SOUTH Improvement Program. The following are my comments:

1) On page 1-17, Section 1.6.6 states that the Florida Department of Transportation (FDOT) plans to install 22 two-foot diameter culverts underneath US-1. This is incorrect, the FDOT is studying the provision of 20 two-foot diameter culverts, NOT 22.

2) On page 8-3, Section 8.5.1.b states that the ACOE assumes that the culvert underneath US-1, required as part of their Alternative 4, will be constructed by FDOT. Since Alternative 6A is the recommended plan, we are proceeding with the design of US-1 with the assumption that the spreader canal will not cross the highway, and therefore no culvert will be required at this location. If Alternative 4 is selected prior to the construction of US-1, the plans will be modified to include the required culvert, provided that there are no significant utility conflicts and the FDOT is given appropriate wetland mitigation credits.

I thank you for the opportunity to comment on this important document, and look forward to being kept abreast of any further developments with this C-111 GRR. Should you have any questions, please contact me at 470-5260.

\US1GRR.M14

FLORIDA DEPARTMENT OF TRANSPORTATION

LAWTON CHILES
GOVERNOR

BEN G. WATTS
SECRETARY

District Six
602 South Miami Avenue
Miami, Florida 33130

OMNIFAX TRANSMITTAL COVER SHEET

DATE: 3/17/94

FAX TO: SUSAN TRAUB-METLY

COMPANY: STATE CLEARINGHOUSE

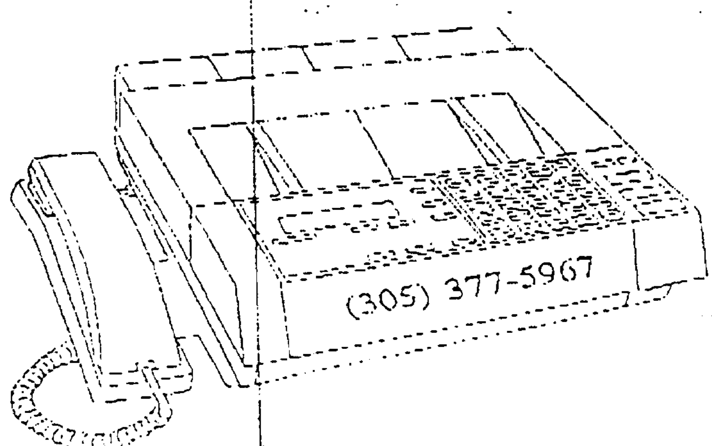
FROM: TODD LEACHMAN

TOTAL NUMBER OF PAGES, INCLUDING COVER SHEET: 3

FAX NUMBER DIALED: 904 488-9005

OUR FAX NUMBER: (305) 377-5967 OUR OFFICE NUMBER: 377.5916

COMMENTS: ORIGINALS TO FOLLOW VIA MAIL



20 Apr 94

C-111 GRR/EIS Corps
MIAMI AIRPORT

Name	Representing	phone
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Karen Humble	South Dade Land Corp	2457089
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Ernie Barnett	FDEP	904 488-0784
Karsten Rist	FLA. Audubon Society	305 238-2864
Eric Draper	The Nature Conservancy	904 222 0199
Frank Bernardino	Dade Co. DERM	305 372-6781
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GLENN LANDERS	CORPS	904-232-7125
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Estus FAX 904-922-6200

C-111 Interagency Meeting
20 APRIL 1994
WEST PALM BEACH, FL

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GERALD ATMAR	Corps	904/232-2615
Jim Sturgis	SFWMD	407 687-6288
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P.B. RHOADS	"	" " 6652
GARY FALLE	"	" " 6231
LINDA McCARTHY	FDEP@SFWMD	686-8800 x2845
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RALPH CANTRAL	DCA/FCMP	904/922-5438
Richard Bonner	Corps of Eng.	904/232-2586
Estus Whitfield	Governor's Office	904/488-5551
TOM MACVICAR	SFWMD	407 687 6237
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Ernie Barnett	DEP	904 488-0784
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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9450 Koger Boulevard
St. Petersburg, Florida 33702

April 18, 1994

A.J. Salem
Chief, Planning Division
Department of the Army
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Salem:

This responds to your February 24, 1994, request for review and comment on the Draft Integrated General Reevaluation Report and Environmental Impact Statement for the Central and Southern Florida Project, Canal 111 (C-111) in South Dade County, Florida.

In general, the document adequately assesses impacts of the proposed modifications. Although the recommended plan differs somewhat from the alternative recommended by the National Park Service (and supported by the National Marine Fisheries Service in our previous comments) in their Hydrological Evaluation of the Proposed Alternatives, we find the plan acceptable, provided the necessary operational adjustments and other remaining issues are addressed during future detailed planning activities.

Thank you for the opportunity to review this report. If you have questions regarding our comments, please contact Ms. Shelley Du Puy of our Miami Field Office at 305/595-8352.

Sincerely,

Shelley DuPuy

for Andreas Mager, Jr.
Assistant Regional Director
Habitat Conservation Division

cc:
F/SEO2
F/SEO23-PC

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICES
SANCTUARIES & RESERVES DIVISION
Florida Keys National Marine Sanctuary
9499 Overseas HWY 1
Marathon, Florida 33050

April 15, 1994

Colonel Terrence C. Salt
District Engineer
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Colonel Salt,

I am writing to you on behalf of the Florida Keys National Marine Sanctuary and the 2800 square nautical miles of priceless natural resources which are protected within its boundaries. These nationally significant resources including seagrass meadows, mangrove islands, extensive hardbottom habitat, patch reefs, and the Nation's only living coral reef tract that lies adjacent to North America, are in jeopardy from declining water quality throughout the Everglades Ecosystem.

In recent months, an unprecedented level of coordination between Federal and State agencies, and involvement by the public, has occurred in order to protect its resources and ensure the livelihood of the Keys community. I applaud the Corps of Engineers commitment to share in this collective effort to restore the Everglades Ecosystem.

This highly diverse ecosystem supports valuable commercial and recreational fisheries and forms the economic basis for the number one industry in the Florida Keys which is tourism and recreation. The major components of the ecosystem are linked through the flow of fresh water from Lake Okeechobee through the Everglades into Florida Bay, where it eventually mingles with Gulf of Mexico waters before moving from the Bay through passes in the Keys onto the coral reef tract. Today this flow has been interrupted by a variety of human manipulations in the South Florida region, resulting in inadequate water deliveries that no longer follow a natural hydro-period (flow pattern). The Bay, which used to be estuarine in salinity, now exhibits high salinities throughout the year and frequently displays hypersaline conditions as a result of decreased freshwater inflow.

An unprecedented consensus now exists among scientists and resource managers of some of this Nation's most significant resources. Serious and progressive degradation is occurring within the Florida Bay ecosystem, and the entire ecosystem may collapse. A crisis of extraordinary proportion jeopardizes this Nation's most diverse and unique natural resources: an ecosystem that the economy of South Florida and the Keys is dependent upon.

The scientists and managers further agree that this crisis is a direct result of flood control, other water management measures, and agricultural runoff that have substantially reduced the amount and quality of freshwater flowing into the Everglades/Florida Bay hydrological system. Likewise, the actual and potential adverse effects of Florida Bay degradation on the marine resources of the Sanctuary have been well documented. As a result, decisions regarding quantity, quality, timing and distribution of freshwater inflows into the Everglades and Florida Bay are of direct and immediate concern to the management of the Florida Keys National Marine Sanctuary.

Dr. Jim Porter has documented the decline of coral habitat on several reefs in the Florida Keys, with his greatest rate of decline being recorded at Looe Key Reef, where he initiated his work in 1984, and where we know the waters of the Gulf and Florida Bay flow. The decline reported by Dr. Porter coincides with anecdotal observations made by many knowledgeable scientists who have visited Looe Key Reef in recent years.

Tortugas pink shrimp landings averaged over 10 million pounds annually during 1963-1980. Since then, annual landings have equaled that average only once, production has been less than 8 million pounds per year, and severe drops below 5 million pounds per year were seen during 1988-1991. Tortugas shrimp fishery production appears to be directly or indirectly linked to freshwater inflow into Florida Bay, the largest nursery area for juvenile pink shrimp in South Florida. While exact mechanisms are not yet known, higher rainfall levels and higher levels of freshwater generally lead to greater pink shrimp production and the lack of freshwater results in less production. In addition, the loss of seagrass habitats has likely exacerbated the decline in pink shrimp production, which appears to have begun before the seagrass die-off.

Research supported by the National Park Service, and carried out by the National Marine Fisheries Service during 1984-1985, demonstrated that the western portion of Florida Bay, adjacent to the Gulf of Mexico, and channel habitats throughout the Bay consistently supported the highest diversity of fish. The channel areas and basins in western Florida Bay also displayed the greatest diversity and density of seagrasses. Statistical analyses indicated close relationships between seagrass abundance and the abundance and diversity of fish populations, including gray snapper and spotted seatrout. The basins in western Florida Bay currently undergoing seagrass die-off and secondary loss of seagrasses as a result of increased turbidity are those areas that had the highest diversity and densities of fishes.

In Florida Bay, the turtle grass (Thalassia) die-off has led to increased acreage of non-vegetated sediments. Loss of seagrass habitat will lead to reduced fisheries productivity, both short-term (as denuded areas take time to recover) and long-term (if reduced water clarity prevents recolonization or induces further die-off).

Seagrass habitats, which dominated the sea floor of Florida Bay, have changed from a mixture of predominately three species (turtle grass, shoal grass, and manatee grass) to largely monospecific meadows dominated by turtle grass. Since the mid-1980s, the generally monospecific turtle grass habitats, particularly in the western portion of the Bay, have been undergoing a die-off with large areas of unvegetated bottom being the end result. Coinciding with this die-off has been an increase in turbidity from both resuspended carbonate sediments and blooms of microscopic algae.

The Florida Keys National Marine Sanctuary makes the following recommendations on the C-111 reconstruction plan:

1. The Sanctuary recognizes that Plan 6A is a step in the right direction. However, it is questionable whether or not it will allow water levels to increase adequately to restore fresh water flow into Florida Bay via Taylor Slough. We recommend that the Corps' seriously reevaluate this plan to ensure adequate fresh water flow into the Bay.

2. The Sanctuary supports the acquisition of the lands west of the L-31/C-111 canals, known as the "Frog Pond and the "Rocky Glades Agricultural Area."

3. The Sanctuary supports the establishment of the retention/detention areas west of L-31, with pumps and structure to deliver water westward into Taylor Slough.

4. The Sanctuary supports backfilling of the C-109 and C-110 canals with 9-10 plugs in each.

5. The Sanctuary supports building a 1,000 ft bridge across State Road 9336 (the road leading to Flamingo) at the Taylor Slough crossing, to replace the current bridge and culverts.

In addition to the above elements contained in the plan, the Sanctuary recommends the following:

1. Replace the proposed C-111N spreader canal with water detention/retention areas running east-west at the head of the C-111 basin.

2. Construct a 500 cfs pump at the S-332E location to accommodate both normal and high rainfall periods.

3. Plug and backfill the existing C-111 canal below the S-18C structure and eliminate the S-197 structure.

The Sanctuary recommends that the Corps expedite every way possible the implementation the C-111 reconstruction plan to prevent any further degradation of Florida Bay as a result of the lack of fresh water flow.

The Florida Keys National Marine Sanctuary wants to commend the Army Corps of Engineers on its' efforts to address the environmental crisis that now exists in Florida Bay. Thank you for the opportunity to be able to comment on the proposed project. If you have any questions regarding the recommendations, please feel free to contact me.

Sincerely,

Billy D. Causey
Sanctuary Superintendent

cc: Ed Lindelof

South Florida Water Management District

3301 Gun Club Road • P.O. Box 24680 • West Palm Beach, FL 33416-4680 • (407) 686-8800 • FL WATS 1-800-432-2045

PRO EVR

April 29, 1994

Colonel Terrence C. Salt, District Engineer
U.S. Army Corps of Engineers
Jacksonville District
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Colonel ~~Salt:~~ Rock

Attached is a summary of our staff comments regarding the Draft of the C-111 GRR. We at the District recognize and appreciate the hard work and dedication of Corps staff in meeting the accelerated schedule for this project. We also support your decision to proceed with the approval process within the Corps now, and to continue to revise the design in the next phase of the process. At the same time, we recognize there are major issues facing all of us in moving ahead on the C-111 project. We understand the importance of reaching consensus on a cost sharing recommendation within the next two weeks, and we pledge to work together with you to find something we can both support.

Based on comments from our staff and others concerned with C-111, a variety of technical issues need further investigation and refinement during future detail design studies. These issues involve design elements, real estate requirements, flood control benefits, and consensus on flow distribution patterns in the lower C-111 basin.

Be assured that the District is committed to working closely with the Corps and Everglades National Park in addressing these issues. We are encouraged by the progress made thus far, and are eager to play our part in addressing the needs of Taylor Slough, Florida Bay, and south Dade County.

Thank you for your help and continuing support with the C-111 effort.

Sincerely,

Til

Tilford C. Creel
Executive Director

attachment
c: Estus Whitfield, Governor's Office
Governing Board Members
Richard Ring, ENP

C-111 General Re-evaluation Report

Staff Review

APRIL 5, 1994

OVERVIEW

The Operations and Maintenance Department expressed some concerns regarding baseline assumptions built into the report. Cross sections given are pre-South Dade Conveyance system, and don't reflect existing configurations. Possible implications arise in that we really don't know how this alternative will reflect flows in the current configuration. Furth[illegible] we don't know whether drawings or modeling are correct. This requires some clarifica[illegible]

Use of optimum water levels in Table 2-1 are at issue. Model results indicating an improvement in flood control show an improvement only over this theoretical scenario. Cost/benefit decisions made on this basis could be misleading. We recommend adding a statement in Section 3.1 that addresses this. We further recommend additional model runs, utilizing current levels to evaluate the true flood benefits of the Alternative selected.

Given current difficulties in deriving an operational plan for limited test areas, we encourage early and earnest efforts to address an operating plan for this project.

Concerns have been expressed by our Planning Department that proposed construction activities will have substantial impacts on large areas of wetlands, especially during the period of construction. It is likely that these disturbed areas may take a long time to recover. These areas need to be protected to prevent invasion by exotic species. A potential mitigation for these impacts may come from conversion of Frog Pond agricultural lands to wetlands, and probable improved water deliveries to the southern glades wetlands of the proposed C-111N canal. To this end, the District would like to see some additional information included in the final design phase that details monitoring, restoration and management plans for the Frog Pond, Rocky Glades and southern C-111 areas.

Acquisition of agricultural "in-holdings" west of C-111 and L-31N is not stated as a defined objective of the GRR. The acquisition of those lands should therefore be subject to economic comparison with alternative means of accomplishing the objectives of the project.

There is no quantitative indication of the extent to which S-197 discharges will be reduced or eliminated by this plan. Such an analysis should be included.

Discussions regarding water quality are not included in this report. A basic analysis of the suitability of direct discharge of water from these adjacent lands to ENP needs to be considered.

INTRODUCTION

A question arose regarding the inclusion of River Basin Monetary Authorization & Miscellaneous Civil Works Amendments Act of 1970 as justification for this report. The act references a number of canals with designations unfamiliar to this group. What happened to these canals? If this Act is mentioned, care should be taken to correlate authorization with reality.

The Interim Plan specifics should be included in Section 1, in addition to current language. This could be used as an introduction to current canal configurations.

The Corps needs to update the Everglades SWIM section to reflect the passage of the Everglades Forever Act (Section 373.4592 FS).

Section 1.6.7 re: Hole in the Donut restoration. Was any incorporation made in the model to take the raised elevation of the eastern Frog Pond into consideration?

EXISTING CONDITION/AFFECTED ENVIRONMENT

Section 2 should be rewritten. There is no flow to it; the information is poorly organized and section 2.4.8 is technically inaccurate. It appears that most of the information came from the Everglades SWIM Plan. District staff would be willing to assist in this re-write.

On pages 2-10 to 2-11, statements are made concerning levels and sources of phosphorus and mercury in the Everglades that need some scientific basis. There are also some literature citations in the text with no follow-up description of the source in the "Sources Cited..." section, such as "FWS, 1991" on p. 2-15; "W.E. Odum et al, 1982" on p. 2-18; and the references cited in the reptiles section on p. 2-20.

FUTURE 'WITHOUT PROJECT' CONDITION

Section 3.2 references the inclusion of Modified Water Deliveries in the future "without project" condition. It indicates that an operational plan is part of MWD. This is not accurate, since there is no consensus on an operating plan for MWD.

Section 3.5 Land Use, 4th paragraph: needs to be rewritten. It is not clear what connection exists between a return to design criteria and the heading "future, without project" condition. Does this imply that if there is no GRR, there would automatically be a return to design optimum? This needs clarification.

Section 3.8, 3rd paragraph: should be eliminated, with suggested language included:

In Manatee Bay, Barnes Sound and Florida Bay, cycles of unnatural salinity conditions will likely continue. Discharges of large flow volumes to coastal receiving waters will occur within short time periods following major storms. This will result in significant swings in salinity, from 0 to levels well in excess of seawater salinity. The impact on the area biota will continue to be significantly negative.

Omit the 2nd Section 3.

PROBLEMS AND OPPORTUNITIES

Section 4.1, 3rd paragraph: question accuracy of sentence, "These flows are collected in the canals and are discharged, for the most part, to the east to Biscayne Bay." The Corps needs to look at the latest water budgets (either from ENP or the District) to discern levels flowing south versus east.

Section 4.1, 6th paragraph: The Corps needs to cite a reference for the values given for agricultural flood damage.

Section 4.3.2, 5th paragraph: The sentence, "By the late 1960's and early 1970's, construction of the L-31N, L-31W, and C-111 canal systems reached completion, and the optimum canal operational stages were lowered in response to expanding agricultural and urban development into the lower lying..." . We question the validity of this statement. The Corps needs to evaluate this statement, and consider if this is in fact the rationale for lowering these operational stages. If it is not, this may not be an appropriate cite for this document. It is also in conflict with recent statements made by the Corps in litigation. Definitely needs clarification.

FORMULATION OF ALTERNATIVE PLANS GENERAL RE-EVALUATION REPORT

Section 5.2.1 Restoration of Historic Hydrologic Conditions, 2nd sentence: should address why water quality is not considered in this report.

Section 5.2.3: No information is included in this section. We've recommended some (reference Section 3.8, 3rd paragraph above).

Section 5.5.1(a) Omit the word "natural". Staff asserts this statement may be true some of the time (during the wet season), but cannot be used as a general statement.

Section 5.5.1: We question whether the criteria suggested equate to "operational flexibility". We interpret that phase to mean the ability to balance all priorities for this plan, including the need to maintain flood protection. There is no mention of any flood protection features in items a-h. Better to define this section as "environmental factors".

Section 5.5.3 Environmental Benefits: typo, p.5-7, first sentence: "demonstration" should be "demonstrate".

Section 5.6 Alternatives: recommend moving this section into the Appendix.

Section 5.6.4.8 Alternative 6, last full paragraph: pump station designated S-332C should be S-332E.

Section 5.6.4.10, Alternative 9, 2nd paragraph: need to relook at environmental effects of curtain wall, and potential impacts on the aquifer and timing & distribution of flows along Everglades eastern wetland area.

Section 5.6.4.11 Alternative 6A: next to last sentence states that "project objectives of restoring natural timing, location...would be addressed by these features." We could find no evidence in your subsequent analyses that the timing of water deliveries was analyzed. Although the modeling runs indicate anticipated water levels and durations, they do not indicate the seasonal distribution of water. This is an issue of equal importance to the amount of water. There is no detailed analysis of the water quality effects of this plan. Presumably operational details will be developed and made explicit during the PED process. Without such details, it is not possible to make a full evaluation of the various alternatives. Second paragraph, last sentence: please reword to the following.

> "A concrete lined canal will be connected to the outlet side and discharge 1/2 mile west through the new S-332D tieback levee into the detention/retention zone."

Figure 5-23 indicates that a new, 1000 foot bridge will be required to replace the existing bridge across Taylor Slough. There is no basis for determining this bridge length. Where did the 1000 foot length come from? Is it necessary to be that long?

{We need additional detail regarding S-332 D pump station discharge: how will it work; general design concept}.

Section 5.10.1 Marl Soil Ecosystem Criteria: on pp. 5-51 and following, we agree that these are suitable conditions for the formation of marl soils, based on Tabb's work, and thus represent a reasonable performance measure. From that point on, the analysis was not very clear. Most of the marl model discussion on the bottom of p. 5-51 and the top of p. 5-53 was very awkward and hard to follow. Likewise, the continuing discussion on pp. 5-53 and 5-55 of Hydrohabitat Index was very confusing. Perhaps it would be clearer if the report included sample calculations showing how some of the actual numbers in Table 56 were derived. pg. 5-53 1st sentence: Section 2.5 is supposed to be marl measurements. Section 2.5 is actually population. Need to find it (we couldn't) and rename appropriate section, or delete that reference.

Section 5.14 Evaluation of Alternative Plans: this paragraph references Section 5.5. Section 5.2 names a separate group of objectives. How do these fit together? Which objectives are driving this process? This needs to be clarified. Recommend clarifying first sentence of Section 5.5 so the reader can better understand how the two sets of objectives are aligned. The two tables (5.8 and 5.9) do not help. Which of the two tables drove the process of choosing the best alternative? We recommend additional words to clarify and answer this question.

Results of hydrological assessment model runs (Figs. 5-26 to 5-36 and Tables 5-10 and 5-11) appear to be based on only one year of data (1976 - 1977). Given the wide variability of S. Florida rainfall, it seems risky to extrapolate very far from this result. Is this an average year?

ENVIRONMENTAL EFFECTS OF RECOMMENDED PLAN

Section 6.6 Water Quality. Again, concerns regarding water quality exist, and we think they should be addressed in this document in much more detail than what is covered in this paragraph.

Section 6.10, p. 6-7, 4th paragraph: Question re: calculation on Rocky Glades population. How do we get from 15 to 50, if 5 households contain 3.2 persons per? Either go with macro estimate, or change number to 16.

RECOMMENDED PLAN

Section 7.1.2 Pump Stations: there is no basis defined for sizing of the pumps (4 @300 cfs = 1200 cfs). Please define the process used to size these pumps.

Section 7.1.2.4, S-332D: Staff needs to understand how pump station discharges flow through the levee "toward" ENP. Is it through the retention/detention area, or directly to the Park? How wide is the top of S-332D? (Operations & Maintenance staff need to have this information to effectively comment from their perspective).

Section 7.1.2.5, S-332E: there is no definition of the basis for selecting 50 cfs capacity of S-332E.

Section 7.1.3.1 Levee 31-W tieback: L-31W tieback goes north to S-332B instead of S-332D (typo on page 7-5). L-31W indicates a levee crown width of 15 feet. District requires at least 18 feet of levee crown width for maintenance purposes (vehicle and equipment access needs). As it pertains to the section of the tieback north of S-176: there is no specific functionl criteria defined for the retention/detention area. It would appear that the retention/detention area is unlikely to have any real influence over the timing of flows into ENP, given its size, and hydraulic gradients involved. With respect to the section of the tieback from S-176 south to S-175: its function appears to be to define a buffer zone, in this case about 1 mile in width. It would appear to have a sole benefit in reduction of seepage inflows, in this case to the C-111 canal. Is this its purpose? If so, is this the most cost effective means to accomplish that end?

Section 7.1.3.2 S-332D Tieback Levee: The function of the levee appears to serve as a "buffer" between the retention/detention area and L-31N. Staff is concerned that seepage rates in the L-31N borrow canal will be significantly impacted by this tieback levee. To that end, this report does not quantitatively address either absolute or differential seepage rates of inflow to L-31N.

Section 7.1.3.7 Eastern Spreader Canal (C-111N): construction of C-111N includes placement of the spoil as a mound on the north bank of the spreader canal. This would appear to interrupt drainage from areas north of C-111N. What will be the impact on upstream properties? This is a question must be addressed. Extension of C-111N across U.S. 1 to provide water supply to "Model Lands" between US 1 & Card Sound road would appear reasonable, but is not included in the project as it is "outside authorization". It would seem reasonable to consider this for the future. Culverts across US 1 are still an issue, requiring additional discussion with DOT prior to implementation of either project.

Section 7.2.1, p.7-7: Need to replace or delete the last sentence of the first paragraph with new text. This sentence seems to contradict the preceding sentences in the paragraph, regarding the interest that needs to be acquired. We assume that the "buffer lands" referred to in the last sentence are the eastern portion of the Rocky Glades, but this is not totally clear.

Section 7.2.2, p. 7-8: There is no discussion of the moving cost payments that may be payable to the residents within the acquisition area. This should be addressed along with some discussion about the obligation to pay for any business relocation moving costs (i.e. moving fruit trees and irrigation system components from tropical fruit groves).

Section 7.3 Monitoring: the overall monitoring plan is very cursory in nature. This needs to be enhanced. The District will cooperate as part of this enhancement effort. Gathering data will be important for future project iterations.

PUBLIC INVOLVEMENT, REVIEW AND CONSULTATION

Section 8.5 Summary of Compliance with Environmental Regulations: Fish & Wildlife Coordination Act, as amended, #8, last sentence. "These subjects are discussed in Section 7.4." They are not discussed in Section 7.4. Should be Section 7.3.

RECOMMENDATIONS

LIST OF PREPARERS

Appendix C, section 7-b, p. C-5: Need to capitalize word "total" in next to last sentence.

Appendix C, section 9. Need to add discussion of residential and business moving costs.

Appendix C, section 10: We are required to do two appraisals when the subject property is valued at more than $500 k. Thus, the number of appraisals that the District will have to do to acquire 300 parcels will be more than 300, given that some portion of the parcels will be valued in excess of $500 k. The Corps should be able to make a reasonable guess as to how many parcels are large enough to require two appraisals. There should also be a discussion about the costs associated with doing title work/obtaining title insurance and environmental audits.

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April 15, 1994

Colonel Terrence Salt
U.S. Army Corps of Engineers
Jacksonville District
P.O. Box 4970
Jacksonville, Florida 32232-0019

re: Draft Integrated GRR and EIS for C-111

Dear Colonel Salt:

By way of this letter, the Everglades Coalition submits its comments on the February 1994 Draft Integrated General Reevaluation Report and Environmental Impact Statement for Canal 111. We consider this project to be a cornerstone in the effort to restore the Everglades system to its former health, recreating a functioning ecosystem containing the same key components and processes which once characterized its pre-project condition. By reference we wish to restate the comments contained in National Audubon Society's January 24, 1994, letter on the same subject.

We wish to congratulate the Corps for making significant improvements in the proposal from when we last saw it. Your proposed retention/detention areas will provide clean water, flood protection and a water barrier between developed lands and the natural Everglades system. Your proposal goes a long way towards restoring sheetflow in this area. We also applaud your proposed acquisition of sensitive lands bordering Everglades National Park. While this draft GRR represents a significant improvement over current operating conditions we believe that further ecological improvements will be achieved with the changes indicated below. We strongly support moving this project forward on its current fast track.

ECONOMIC IMPACT

The economic analysis for this project is flawed because it does not incorporate the cost of the collapse of Florida Bay versus the benefits of restoring it. The degradation of Florida Bay has endangered the economy of the entire Florida Keys which is based in large part on fishing and diving. Scientists agree restoration of freshwater flows is one essential ingredient to the restoration of the Bay. Since a primary objective of the C-111 GRR is to restore natural flows through Taylor Slough into the Bay, the economic benefits of environmental recovery to these industries should be quantified and will provide additional economic justification for this project.

ACHIEVING FULL RESTORATION

As described in the Ogden et al (1993) Report, "Environmental evaluation for the structural alternative plans for the C-111 draft GRR, submitted to the U.S. Army Corps of Engineers, December 1993", extensive ecological degradation of the Taylor Slough and C-111 basins has occurred. This degradation has occurred primarily as a result of changes in hydrological conditions caused by structural and operational water management practices in the South Dade Conveyance System (SDCS). Water levels in the marshes of Taylor Slough, Rocky Glades and the C-111 basin have been significantly lowered. Depths during the wet season now are as much as 2 feet lower in some areas (Johnson and Fennema 1989, Loftus et al 1992, Van Lent et al 1993, and Van Lent and Johnson 1993). Further, the distribution and timing of water deliveries has been significantly altered.

These reductions in water depths have reduced hydroperiods basinwide, resulting in changes in periphyton communities affecting the rest of the food chain. This hydrologic disruption adversely affects the number of fish present which affects the use of the area by predators such as birds (Bancroft 1993; Affidavit, South Dade Land Corp. v. Sullivan). This has apparently led to the widespread reduction in the use of this area by a suite of wetland dependent species including Wood Storks, American Alligators, Wading Birds, Roseate Spoonbills and fish.

The Congressional mandate for this General Reevaluation Report (GRR), is to make structural modifications to the C-111 basin canal system which are capable of imparting "restoration of the ecosystem in Taylor Slough and the eastern panhandle of Everglades National Park (ENP) . . . ." To meet this goal, these and future modifications, as well as the establishment of operational criteria must be designed to achieve hydrologic and ecological restoration. Ogden et al (1993) list four important restoration objectives for these basins which we support:

a. The recovery of keystone/indicator species, including pre-drainage wading bird nesting colony patterns, alligator reproductive patterns, and freshwater fish population movement and survival patterns;

b. The recovery of viable populations for all endangered and threatened species;

c. Reestablish the upland freshwater source to mangroves and coastal wetland communities to restore their natural productivity and ecological important detrital export to estuaries;

d. The re-establishment of more natural spatial and temporal patterns of salinities in coastal estuaries.

Achieving the goal of ecological restoration will require changing the works and operations of the system in such a way that sufficient water will be placed in the correct places at correct time to achieve hydrologic restoration. Flexibility is essential to the development of a delivery system that mimics historic hydrologic conditions in the marshes. The project must also be done in a manner that the flood control obligations of the Corps are maintained in the developed areas.

To ensure that this ultimate goal of ecological restoration is met, we recommend that the Corps immediately take the following actions aimed at more precisely refining the process and goals of restoration:

1. Undertake a complete review and evaluation of all historical and current information to better define natural ecological functions for the affected area (with particular attention given to pre-SDCS information).

2. Begin development of a fine scale natural systems model capable of providing an estimate of pre-project hydrologic conditions. This is vital to measuring the success of the project.

3. Create a comprehensive hydrologic and biologic monitoring program capable of providing the quality, quantity, breadth and scope of information necessary to fully evaluate the relative success of initial structural and operational modifications. These data will be important for designing future improvements and modifications to system operations if ecological restoration is not achieved by initial structural and operational

changes under this GRR. The critical parameters outlined in the Ogden et al (1993) report on biological assessment should be included in the monitoring program. The program should utilize other information necessary to evaluate the success of the project gathered by Everglades National Park, National Biological Survey, Florida Keys National Marine Sanctuary and other natural resource managers.

PROPOSED STRUCTURAL MODIFICATIONS

We believe the preferred alternative (6A) makes significant progress towards providing the general structural modifications needed to recreate natural hydrologic conditions in northern Taylor Slough. We feel strongly that the process of achieving full ecological restoration of this area will be an iterative one. As the operations plan for this revised system is developed and tested, we expect some structural details to change to accommodate optimal operation. We support efforts to build a system capable of flexibly meeting the entire range of natural water delivery conditions.

Changes to the preferred alternative are required to more likely provide full ecological restoration of the southern portion of the C-111 basin and the southern portion of Taylor Slough. We recommend the following modifications be made to the preferred alternative:

1. The size of the proposed retention/detention basins are insufficient to meet the ecological restoration goals of the project. Therefore, we need to expand the two cell retention/detention area north to Tamiami Trail as suggested in Alternative 8 and south along C-111 through the Frog Pond past the entrance road to the Park to the end of the farmlands as suggested in Technical Report SFNRC 93-4. This larger strip or series of cells will provide more capacity for capturing runoff from the developed areas to the east, providing flood protection, accommodating supplemental deliveries from the north, cleansing water, and providing the flexibility to correctly time the release of water into Everglades National Park. Furthermore, a water barrier in this area is essential to reducing the seepage of water out of Northeast Shark Slough in Everglades National Park. This integrated approach will also allow the maximum flexibility to coordinate water deliveries between Northeast Shark Slough and the C-111 basin.

2. The placement and size of the S-332 pumps and associated culverts must be designed to achieve full ecological restoration of the Rocky Glades and headwaters of Taylor Slough. In a restored system we don't believe the current S-332 will allow the western portion of the Frog Pond to receive natural patterns of water deliveries. By replacing the present S-332 with a conversion of the

northernmost east-west section of the L-31W canal into an open ended spreader canal, the system will be capable of recreating sheetflow across the historic headwaters of Taylor Slough. Sheetflow can also be enhanced by using a continuous series of culverts along the western side of the retention/detention basins from Tamiami Trail south. This is preferable to the proposed alternative for two reasons. First, water delivered via this canal will be capable of restoring hydroperiods in northern Taylor Slough, particularly through its historic headwaters, rather than bypassing them to be injected at S-332. Second, a spreader canal will recreate more natural distribution than use of S-332 as a point source discharge.

3. To achieve restoration of the southern part of the system , historic patterns of flow must be recreated. To achieve this the following should become part of the GRR.

- The C-111N canal should become one side of a retention/detention area extending from the south end of the Frog Pond ranging east through a gated structure under Card Sound Road.

- The C-111N canal should be placed as far north as possible, south of the upland contour line and linked with the retention/detention area to the north. This northern placement is critical for restoring flows in this area and for spreading flood waters over a larger area.

- Two-way pumping capacity between the Rocky Glades/Frog Pond retention/detention area and this extension should provide maximum operational flexibility. Larger pumping capacity (at least 500 cfs) will provide the flexibility to remove flood waters from the C-111 basin and discharge them into the retention/detention area along the C-111N canal.

- Removal of the C-111 south of S-18C as an active canal is critical for the restoration of sheet flow across this area of the Everglades and to prevent pulse discharges into Manatee Bay and Barnes Sound.

These changes are necessary for three primary reasons.

First, the proposed location of C-111N severs hundreds of acres of high quality wetland marsh from the rest of the basin. This severance will result in further degradation of habitat as well as preclude recreation of natural ecological conditions.

Second, the proposed spreader canal is incapable of improving the timing of flows to the area -- a critical component of ecological restoration. Unless flows are extended over time in a way that matches historic natural delivery patterns (something a spreader canal cannot do), natural ecological conditions cannot be recreated. By substituting an extension of the retention-detention areas, the ability to control timing as well as distribution of flows is enhanced.

Furthermore, by adding this new retention-detention area, flood control obligations can be met while allowing the land south of this area to be used solely for restoration objectives. We must eliminate the possibility of further pulse damage to Barnes Sound and Manatee Bay as well as prevent sheetflow disruption by the lower extent of C-111. Even without flushes from C-111, unnatural releases of freshwater may unbalance Manatee Bay's estuarine environment. These goals may be accomplished through filling C-111 south of S-18C, or if cheaper and fully effective, through a series of closely spaced plugs.

We look forward to your revised GRR with great anticipation.

Sincerely,

Thomas D. Martin
Co-chair

Joseph Browder
Co-chair

Theresa Woody
Vice-chair

cc: Tilford Creel
Richard Ring

Members of the Coalition include:

American Rivers

Audubon Society of the Everglades

Biodiversity Benefits

Center for Marine Conservation

Clean Water Action

Defenders of Wildlife

Dunlop & Browder

Environmental Defense Fund

Fishermen Against Destruction of the Environment

Florida Audubon Society

Florida Bay Initiative, Inc.

Florida Defenders of the Environment

Florida Keys Audubon Society

Florida Lake Management Society

Florida PIRG

Florida Wildlife Federation

Friends of the Everglades

Izaak Walton League

League of Women Voters of Florida

National Audubon Society

National Parks and Conservation Association

Everglades Outward Bound Center

1000 Friends of Florida

Reef Relief

Save Our Everglades, Inc.

Royal Palm Audubon Society

Sierra Club

SCLDF

Tropical Audubon Society

The Wilderness Society

Florida Conservation Association

United States Department of Agriculture

Forest Service

Southern Region

1720 Peachtree Road, NW
Atlanta, Georgia 30367

Reply to: 1950-4

Date: March 16, 1994

Mr. A. J. Salem
Chief, Planning Division
Department of the Army
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Salem:

Thank you for the opportunity to review the draft Integrated General Reevaluation Report and Environmental Impact Statement on the Canal 111 Project. As this will have no impact on National Forest lands, we have no comments.

Please continue to provide us with the opportunity to review other Corps of Engineers environmental documents.

Sincerely,

MARVIN C. MEIER
Acting Regional Forester

cc:
P&B

TROPICAL AUDUBON SOCIETY, INC.

5530 Sunset Dr., Miami, FL 33143
Phone (305) 666-5111

THE VOICE OF CONSERVATION IN SOUTH FLORIDA

March 11, 1994

Colonel Terrence C. Salt, District Engineer
Jacksonville District, U.S. Army Corps of Engineers
P. O. Box 4970
Jacksonville, FL. 32232-0019

Dear Colonel Salt:

Thank you for your response to my letter of January 3, 1993, which reached me through the office of Senator Graham. We certainly have great hopes for the comprehensive review study of the C&SF project. However at this time we are very concerned about the GRR for the C-111 basin. We are keenly aware that the solutions which the draft GRR proposes ultimately have to fit into the larger picture of the comprehensive review study and of Everglades restoration.

We find that alternative 6A, the preferred alternative, maintains the southern reach of canal C-111 and structure S-197. Everglades National Park shows C-111 filled or plugged and structure S-197 deleted in their alternative #4 and their later alternative #8. We concur. The only reason for keeping C-111 and S-197 operational is to use them for the purpose of draining flood waters from the C-111 basin into Barnes Sound. This is an unacceptable use.

The draft GRR describes on pages 4-2 and 4-3 the damage caused by the release of flood waters when the plug was removed at the end of the C-111 canal in 1988. With S-197 in place the impact would likely be less severe. However, we believe that such flood waters could have a significant positive impact on Florida Bay if we provided a means to get them there.

We surmise that the Corps' engineers felt that it was necessary to keep C-111 and S-197 operational to assure flood protection for South Dade farms and residences.

We would like to recommend a different structural solution to achieve flood protection for South Dade. Alternative 6A shows a buffer zone/treatment area west of L-31N. The same kind of buffer should be established south of the areas under cultivation in the C-111 basin. Such a buffer is also shown in National Audubon's "Report on Water Supply Preserves". C-111 would be plugged or filled.

If we experience heavy rains and South Dade is threatened with flooding, drainage would be achieved by pumping water out of the northern boundary canal over the levee into the treatment area. From there the water would sheet flow south and ultimately reach Florida Bay.

This design has three significant benefits over alternative 6A:

1) No destructive discharges of water into Barnes Sound.

2) All fresh water potentially available for Florida Bay will reach the Bay.

3) Water quality issues which might exist now or which might result from future land use decisions can be dealt with by an appropriate design of these treatment areas.

More importantly this design concept will solve some of the longstanding conflicts over water management between the requirements of residents and farmers in South Dade and the needs of Everglades/Florida Bay restoration. The C-111 project must ultimately be successful in the political arena to attract the necessary funding for its implementation. The proposed design will help to achieve this end. Because of these important advantages we urge the Corps to model the alternative described above.

We are also concerned about the significant differences between Everglades National Park's alternative 8 and alternative 6A north of the proposed structure S332A. If the 8 1/2 square mile area should come into public ownership, then the area north of S332A should look more like it is shown in alternative 8. The levee design of alternative 6A south of S332A should be extended to the north to provide flood protection for residents and agriculture to the east while making it possible to raise water levels in the Park. If L-31 N remains the only dividing structure then water management will continue to face the dilemma of either flooding agricultural areas because of high canal stages or of draining everglades wetlands because of low canal stages.

Our last comment relates to alternative 9. The consultants employed by the South Dade Land Corporation estimated the cost of their proposed solution to be about 1.4 million dollars per mile at their upper limit. The Corps' engineers computed 6.6 dollars per mile. The difference between the two estimates is too large to be ignored and deserves a full explanation.

Sincerely,

Karsten A. Rist

Karsten A. Rist

UNIVERSITY OF
FLORIDA

Institute of Food and Agricultural Sciences
Tropical Research and Education Center

18905 SW 280 Street
Homestead FL 33031
Tel. (305) 246-6340
Fax (305) 246-7003

Department of the Army
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

April 1, 1994

Dear Colonel Salt:

I recently attended the Public Meeting on the C-111 Basin held on 29 March 1994 at Homestead Senior High School. Unfortunately, I had to leave at 11:00 pm and did not get a chance to address you and the SFWMD representatives. I will therefore submit written comments concerning the Central and Southern Florida Project - DRAFT - Integrated General Reevaluation Report and Environmental Impact Statement - CANAL 111 (C-111) SOUTH DADE COUNTY, FLORIDA.

1. All Project Partners need to remember the original flood control legislation (Flood Control Acts of 1948 and 1968) was intended for drainage, flood control, and flood prevention and that subsequent legislation mandates that flood control and prevention be given equal weight and consideration in any attempts to reestablish more natural water flow and hydroperiods in Everglades National Park. In general, this document tries to minimize and gloss over this fact.

2. Agricultural representatives from South Dade County should have been Project Partners from the beginning of the development of this plan. Agricultural representatives should be included in any further planning and decision making.

3. Alternative Plan #9 was given very inadequate and cursory treatment in the document and should be looked at in much more depth and perhaps tested.

4. There is a lack of any scientific data concerning water quality and the agricultural practices in South Dade County and any insinuations (found throughout the text and in tables) that agriculture is polluting the fresh water should be taken out.

5. Section 6.8 contains inaccurate agricultural statistics which tends to minimize the scope, diversity, and economic value of the agriculture in the Rocky Glades area. Fruit crops grown in that area include mangos, 'Tahiti' limes, lychees, carambolas, guavas, and longans.

6. Flood control and protection is missing from the Operational Control Section (5.5.1). Flood control and protection for agricultural lands west (i.e., Frog Pond, Rocky Glades) and east of L-31N and the C-111 canals should be a part of the evaluation criteria for each proposed alternative plan.

7. Under Evaluation Criteria and Tables:
<u>Table 5-2</u>
In the row on Community Cohesion you indicate no change (0) for any of the plans. This is not the case for those plans where agricultural land (e.g., Rocky Glades, Frog Pond) is taken out of production. There will be a definite economic, social, and economic impact on the land owners, their families, accessory businesses, and the community.

In the rows on Displacement of Business and Displacement of Farms you indicate no change and negative changes (loss) due to most of the plans, respectively. However, in reality farming is a business and so are the businesses that serve farming (e.g., packinghouses, fertilizer companies, tractor companies, etc.), therefore the Displacement of Business row should also show negative changes (losses) due to most of the plans.

<u>Table 5-3</u>
The information on the economic impact to agriculture, the community, the county and state are missing.

Table 5-4:
This table on economic evaluation of the various plans neglects the negative economic impact on the loss of farm land and accessory industries in the Annual Benefits row.

Other comments

1. Why has there not been an agricultural economic impact study conducted on the effect of the various plans? Dade County is number five in agricultural receipts in the State of Florida (Annon, 1993) and a recent study by the University of Florida indicates sales of agricultural products contributed $910

million dollars to Dade county output (Mosely, 1990). In addition, the annual value of the vegetable crop is over $293 million and the tropical fruit crops industry $74 million.

All of the proposed plans except perhaps Alt. #9 will greatly affect agriculture and the accessory industries that serve it. The Central and Southern Florida Project - DRAFT - Integrated General Reevaluation Report and Environmental Impact Statement - CANAL 111 (C-111) SOUTH DADE COUNTY, FLORIDA document does not objectively nor thoroughly access the true ramifications of the various plans on Dade County, Florida.

2. The fresh surface water and Biscayne aquifer from Lake Okeechobee south is connected and water levels in the Frog Pond and Rocky Glades area are affected by water levels to the northeast and northwest. Therefore, the effect of pumping water from the mainland to the Keys, of surface obstructions such as the Tamiami Trail and roadways that protrude into the Everglades (e.g., road to Flamingo and Shark River Slough), and the proposed development and pumping from the West Wellfield should all be studied and factored in with respect to the various plans proposed for the C-111 Basin.

3. None of the plans, including 6A appear to adequately address water levels, flood control, and flood prevention east of L-31N and C-111.

4. Hydrologists from outside the Army Corp and SFWMD should be given the opportunity to officially and objectively evaluate the proposed plans contained in this document. Furthermore, outside review by hydrologists of the entire water management problem for Everglades National Park and agriculture should be seriously considered.

In closing, it does not appear that the Central and Southern Florida Project - DRAFT - Integrated General Reevaluation Report and Environmental Impact Statement - CANAL 111 (C-111) SOUTH DADE COUNTY, FLORIDA plan was objectively written, nor were the various plans investigated or objectively analyzed. Any proposed plan that has such economic impact on the lives of thousands of people, affects so much land and productive agriculture, and that will potentially cost millions of dollars necessitates careful, objective, planning.

Thank you for this opportunity to comment.

Sincerely,

Jonathan H. Crane

Jonathan H. Crane, Tropical
Fruit Crop Specialist

Citations

Annon. 1993. Touring Florida Agriculture. FL. Dept. of Agric. and Consumer Services, Bob Crawford, Commissioner, 545 E. Tennessee St., Tallahassee, FL 32308

Moseley, A.E., 1990. Economic Impact of Agriculture and Agribusiness in Dade County, Florida. Industry Report 90-4. Food and Resource Economics Dept., Univ. of FL, Gainesville, FL.

MICHAEL F. CHENOWETH
ATTORNEY AT LAW
31 GARDEN COVE DRIVE
KEY LARGO, FLORIDA
(305) 451-0993

April 6, 1994

MAILING ADDRESS:
POST OFFICE BOX 236
HOMESTEAD, FLORIDA 33090

Colonel Terrence Salt
U.S. Army Corps of Engineers
Jacksonville District
Post Office Box 4970
Jacksonville, Florida 32232-0019

RE: Central and Southern Florida Project
C-111 Plan

Dear COL Salt:

The following comments are submitted on behalf of the Florida Division of the Izaak Walton League of America, Inc. with regard to the above issue.

As I reviewed the District's Draft Integrated General Reevaluation Report and Environmental Impact Statement, it struck me that much of the problems we are having is due to the attitude of our culture that we can take a natural place and change it to suit us, without regard for the consequences of our actions. South Florida would not be habitable for most of the residents without artificial drainage and air conditioning, but the drainage which has been forced on the land is now showing its inevitable results in the pollution of the Everglades and the death of Florida Bay. I was forced to wonder how many more engineering-based plumbing solutions we can implement before we realize that the protection of our water supply, our fisheries, and the other amenities which made Florida attractive and useful in the first place depend on real restoration of the historic wetlands and drainage regimes.

The Florida Division supports the efforts of the Corps of Engineers to remediate the problems of Florida Bay. We strongly endorse the proposal to acquire the Frog Pond and Rocky Glades.

It is unfortunate that the proposal does not include immediate acquisition of the 8.5 square mile area. The problems which these three areas present are reflections of the District's and Dade County's lack of effective wetlands protection and use of after the fact permitting to allow activities which were known at the time to be damaging to the system. The problems which exist now were predictable results of making political compromises at that time, instead of acting to protect the resource.

The proposal for the C-111 canal is insufficient to address the continuing threat it poses to disruption of the water quality and distribution in Florida Bay, Barnes Sound and Card Sound. As you are certainly aware, a few years ago, these areas were profoundly damaged by the unchecked release of billions of cubic feet of fresh water into a system which had adapted to hyper-saline conditions, in order to appease a few Homestead farmers who might have had wet tomatoes. Residents of Blackwater Sound reported massive kills of all sorts of marine organisms, including fish, lobsters, and seagrasses. The damage to the natural system which occurred cannot be overemphasized. Friends reported at least one eight pound spiny lobster killed by the fresh water. I belive that the current algae bloom condition of Florida Bay was either triggered or reinforced by the irresponsible release of that fresh water.

Now, the Corps' proposal is to remove the spoil along the C-111, which should be used to refill and permanently close that canal, and use it instead for fill for the L-31-W tieback levee. This proposal is unacceptable. C-111 south of at least S-18-C must be permanently brought back to grade, and sheet-flow throughout the Southern Glades must be reestablished west of US-1. This should include the refilling of C-109 and C-110 as well. Any incidental flooding which might occur as a result probably would have occurred anyway had not the Corps and the State of Florida meddled in the original natural drainage system.

It is not credible that the Corps must use spoil from C-111 as fill for L-31-W when the National Park is proposing, in a permit submitted to your office, to place 9.5 million yards of fill in wetlands elsewhere in the Everglades. It was originally proposed to be put in the Frog Pond, and now I am told it is being proposed to be put somewhere in Everglades National Park. To the extent that fill is required for L-31-W, it should be taken from the Hole-in-the-Doughnut spoil, and not from fill which could be used to refill and restore the site of C-111.

It is obvious that the Corps' proposal is too little, too late, and that much more, such as acquiring the 8.5 square miles, and elimination of canal-directed drainage-motivated discharges to the sea between Vero Beach and Miami, around to Fort Myers, remains to be done. What your staff has proposed, however, is an important first step, and with the reservations outlined above, we endorse the effort.

Very sincerely yours,

Michael F. Chenoweth

Michael F. Chenoweth, Vice President
The Florida Division of the Izaaak
Walton League of America, Inc.

cc: Dr. Carl Keeler, President

South
Florida
Regional
Planning
Council

March 24, 1994

Mr. A. J. Salem
Department of the Army
P.O. Box 4970
Jacksonville, FL 32232-0019

RE: SFRPC #94-0303 - Review of the Draft Integrated General Reevaluation Report and Environmental Impact Statement on the Canal III Project; U.S. Army Corps of Engineers, South Dade County, FL

Dear Mr. Salem:

In response to the Draft Integrated General Reevaluation Report and Environmental Impact Statement on the C-111 Project, Council staff has recognized key regional issues, findings, and recommendations germane to the project. Regional issues addressed in the draft reevaluation report include the following:

- Wellfield protection
- Flood Damage
- Florida Bay Restoration
- Surface Water Management
- Infrastructure Cost
- Flood Control
- Freshwater Flows to Florida Bay
- Environmental resource protection and management
- Water Resources Management
- Urban growth and development

Many positive impacts on wetlands and water resource issues will potentially result from proposed alternative project. However, Council staff recommends that project reviewers make use of specific technical studies prepared by federal, state, regional, and local government agencies on the comprehensive impacts of the proposed alternatives. The following goals and policies of the *Regional Plan for South Florida* should also be used as reference and directional tools to address the project's regional issues.

Policy 8.1.1 Developments proposed for large undeveloped recharge areas of the aquifer will ensure that the recharge potentiai of the property is not significantly altered from the pre-development rate by leaving the greatest possible amount of the property permeable and by retaining and filtering runoff.

Policy 8.1.11 The impact on wetlands will be analyzed as part of planning and development of future wellfields to ensure that hydrologically sensitive habitats will not be adversely affected.

Policy 8.1.12 Water system planning and development programs shall be consistent with water availability, use, allocation, and management plans and coordinated with the South Florida Water Management District.

Policy 8.1.17 Encourage and assist in increasing coordination among all agencies in the development of hydrologic studies on the groundwater resources of the Region.

3440 Hollywood Boulevard, Suite 140, Hollywood, Florida 33021
Broward (305) 961-2999, Dade and Monroe (305) 620-4266, FAX (305) 961-0322

Policy 8.1.18 Local and regional agencies should encourage and assist in the development and implementation of comprehensive water management plans and programs for the Region that are consistent with state and South Florida Water Management District plans. These plans should include water use guidelines for urban development.

Policy 8.1.19 Encourage and assist in increasing coordination between water management programs and land use planning efforts to ensure the long-range maintenance, allocation, and enhancement of the Region's water resources.

Policy 8.1.22 The state, South Florida Water Management District and local governments shall protect the water supply for the Everglades National Park, state park lands, and other environmentally significant areas.

Policy 8.1.27 A definitive examination of historical water level data should be undertaken in conjunction with computer modeling of the interaction of the groundwater and surface water systems. At a minimum, the objectives should include:

a) the effect of surface water management systems on groundwater;
b) a determination of the elevation at which groundwater and surface water will stabilize;
c) the effect of the determined water level on potable water supply and salt water intrusion; and
d) the effect of projected sea level rise on groundwater quality and quantity.

GOAL 8.2 To protect groundwater quality and quantity and where feasible, improve water quality.

Policy 8.2.1 Discourage water management and development projects that may alter the natural wet and dry cycles or cause functional disruption of wetlands and aquifer recharge areas.

Policy 8.2.2 Encourage the maintenance, restoration or creation of wetland areas to provide natural cleansing of surface water runoff and to aid in aquifer recharge.

Policy 8.2.6 Require the use of generally accepted best management practices to reduce or prevent groundwater pollution particularly in aquifer recharge areas.

Policy 8.2.12 Prior to allowing any modifications to existing groundwater control elevations in the Region, the South Florida Water Management District should evaluate. the following:

a) the effect on water quality in the Region;
b) the effect on salt water intrusion in the Region;
c) the effect on the Region's water supply; and
d) the effect on marine resources.

Policy 8.3.2 Wellfield protection programs, including appropriate ordinances, shall be developed and implemented which address as a minimum, condemnation or elimination of existing inappropriate land uses, prohibitions, structural containment safeguards, monitoring, emergency reporting and clean up, personnel training, inventory, and financial responsibility.

GOAL 8.4	To provide adequate flood protection while maintaining surfacial water quality, protecting natural ecosystems, and providing for adequate aquifer recharge.
Policy 8.4.1	Surface water management systems should be designed, at a minimum, to meet level of service standard "C" as shown in Figure Policy 8.3 of the background statement, unless natural resource, water supply or related factors preclude this.
Policy 8.4.9	All project lakes of new developments should be designed so as to prevent the direct discharge of stormwater runoff in these lakes.
Policy 8.4.13	Encourage the establishment of natural vegetation buffer zones and gradually sloping berms away from artificial waterways in order to increase safety around the lakes and prevent the direction of contaminants into adjacent water bodies.
Policy 8.4.14	A vegetated and functional littoral zone shall be established as part of any new surface water management system of lakes greater than or equal to 0.5 acres in size. Prior to construction of the surface water management system for any phase of a project, the developer shall prepare a design and management plan of the wetland/littoral zone that will be established as part of these systems. The littoral zone established shall consist entirely of native vegetation and shall be maintained permanently as part of the water management system. At a minimum, 10 square feet of vegetated littoral zone per linear foot of lake shoreline shall be established as part of the surface water management system. This vegetated littoral zone habitat shall be located such that no less than 50 percent of the total shoreline is buffered by a minimum width of 10 feet of vegetated littoral zone habitat.
GOAL 8.5	Eliminate the net loss of functional values of wetland systems in the Region and protect remaining wetland systems.
Policy 8.5.2	Degradation or destruction of functional wetlands and deep water habitats will occur in the Region only if: a) the activity is necessary to prevent or eliminate a public hazard, and b) the activity is in the public interest and no other reasonable alternative exists; and c) the habitat functions and values are significantly less than those typically associated with such habitats and the habitat cannot be reasonably restored, and d) the activity is water dependent, but in no case shall the activity be allowed for obtaining fill; and e) the activity does not destroy the habitat of threatened or endangered species.
Policy 8.5.13	As a site is developed, invasive exotic plants will be removed from areas to be developed as well as areas to be left in a natural state or as part of the landscaping.
Policy 8.5.14	Coordinated efforts among local, regional, state and federal agencies to indicate invasive exotic plants should be implemented.

Policy 8.5.15 For those projects located in areas that were historically wetlands, development review and approval shall include consideration of the mitigation of historical wetland loss in addition to any wetland loss as a result of the proposed project. If the site has no wetlands at the time of review, and if appropriate, the applicant shall create and maintain a minimum of one percent of the total site acreage as wetlands. If the site has wetlands, those wetlands shall be preserved, or if appropriate, their loss mitigated consistent with Regional Policies 8.5.3 and 8.5.4. Mitigation banking and off-site mitigation may be considered under either scenario.

Policy 8.5.16 Project lakes for new development will be constructed with at least a 4:1 (horizontal to vertical) side slopes to a depth of at least two feet below the water control elevation. These areas will be planted with vegetation acceptable to the reviewing agency and maintained until an appropriate annual survival rate is maintained.

GOAL 10.1 Beginning in 1991, maintain or increase the percentage of the area of natural systems in the Region based on the area documented in local government comprehensive plans.

Policy 10.1.1 As a site is developed, invasive exotic plant species shall be removed.

Policy 10.1.2 Discourage the introduction and spread of invasive exotic plants in the Region.

GOAL 10.2 By 1995, increase the effectiveness of regulations designed to protect and enhance the long-term productivity of natural systems.

Policy 10.3.1 Discourage activity reducing or adversely altering the habitat of an endangered or threatened species or species of special concern.

Policy 10.3.8 In the review process, developments which contain potentially significant habitat or species shall, at a minimum, be required to:

a) inventory the site with an approved methodology and provide the results of the survey to reviewing agencies; and
b) either preserve the habitat of the species with appropriate buffers or relocate the species and habitat if determined acceptable by the U.S. Fish and Wildlife Service and the Florida Game and Freshwater Fish Commission.

All inventories must occur during the time of year that the anticipated species or plant community may be observed.

GOAL 10.5 By 1995, identify lands and develop land acquisition and management practices in the Region which integrate and provide a sufficient water supply and protect wildlife and natural resources.

Policy 10.5.7 Encourage the use of tax incentives, transfer of development rights, and other means to protect flood plains, floodways, and significant wetlands.

Policy 12.1.5 Increase participation in recycling program and the use of recycled goods on all levels.

GOAL 14.1	Beginning in 1991, minimize the impacts of mining on the health of the citizens of South Florida.
Policy 14.1.1	Utilize methods to prevent permanent groundwater and surface water contamination during mining operations.
Policy 14.1.6	Department of Environmental Regulation regulations for mining shall be met to reduce point of source pollution.
GOAL 14.2	Return all mined areas to natural or other productive use upon completion of mining activities.
Policy 14.2.1	All companies planning to commercially mine resources in the Region will file a reclamation plan prior to commencement of mining activity.
Policy 14.2.2	Reclamation plans will include guidelines for final use and design of completed mines. These guidelines will include, but not be limited to: a) use of the land, depending on location (urban, residential, etc.); b) desired natural function, (wildlife habitat, wetland enhancement, etc.); c) slopes for littoral zones; and d) a stated reasonable and practical time period in which restoration is to occur.
Policy 14.2.3	Coordinate current state and local mining regulations and reclamation plans to ensure that financial means are available to obtain sufficient reclamation.
Policy 14.2.4	Prepare an inventory and reclamation plan for abandoned mining areas.
GOAL 16.1	Establish a planning framework for regional land use with a planning horizon of at least 20 years by 1995.
Policy 16.3.7	Existing natural wetlands which are pristine or of high quality will be incorporated into the site plans of developments in the Region, or preserved in such a way that they are not adversely impacted.

Thank you for the opportunity to comment. Please call, if you have any questions.

Sincerely,

James H. Graham, Jr.

James H. Graham, Jr.
Senior Planner

JHG/kc

PD

COUNTY of MONROE
KEY WEST FLORIDA 33040
(305) 294-4641

BOARD OF COUNTY COMMISSIONERS
MAYOR, Jack London, Distict 2
Mayor Pro Tem, A Earl Cheal, District 4
Wilhelmina Harvey, Dictrict 1
Shirley Freeman, District 3
Mary Kay Reich, District 5

District Four
Marathon Government Annex
Suite 110
490 63rd Street, Ocean
Marathon, FL 33050
Telephone: (305) 289-6000
FAX: (305) 289-6013

April 4, 1994

COL Terrence Salt
Jacksonville District
Army Corps of Engineers
Post Office Box 4970
Jacksonville, FL 32232-0019

Dear COL Salt:

Thank you for being at the public hearings regarding the plans to restore fresh water to the Everglades, held in Homestead, March 29, 1994. I thought you personally handled the crowd just right. Unfortunately, the same cannot be said for your assistant.

When I was a Lieutenant in the Corps thirty years ago, we had better sound systems than the one that was used at the hearing. I am disappointed that a better system was not available.

Although I signed up to speak, I was not allowed the opportunity prior to my departure on the bus which brought us to the hearing.

The "T" shirt I presented to you is a statement of our concerns. You saw many of us wearing those shirts, although there were not enough for all of us from the Keys. Those with shirts accounted for only about half of the people from the Keys. If you were to hold hearings in the middle of the Keys, there would be many many more people in attendance.

To briefly summarize Mayor London's message, which contained many important statistics, "Our environment is our economy". The problems in Florida Bay may effect 80,000 Monroe County residents, in some way. Obviously directly effected are the fishermen and guides, and as the pea green mess approaches the inhabited Keys, property values drop, visitors are fewer which in turn effects all businesses in the Keys. The problems in the Everglades and Florida Bay obviously has a greater impact on Monroe County residents than to the farmers whose numbers by their own admission, only account for a high of 6,000.

One gentleman from the Farm Bureau mentioned his concern that the elected officials were not doing anything to resolve the issue. I served on the South Florida Regional Planning Council last year and during that time, there never was a Commissioner from Dade County in attendance. I have at several Florida Bay meetings held by the South Florida Water Management District and the Corps of Engineers, and have never seen a Dade County Commissioner in attendance. Apparently they have little interest in this problem.

I have not studied the proposed plan 6A in detail so I don't offer any technical solutions. I only request that your efforts be to restore the Everglades and Florida Bay to its natural condition as much as possible and in the most cost effective manner.

Thanks again for your attendance at the public hearing.

Sincerely,

A. Earl Cheal

A. EARL CHEAL, DBA
Mayor Pro Tem

AEC:mkn

cc: Monroe County Board Of County Commissioners

salt0055.68/PEO

Danny L. Kolhage

CLERK OF THE CIRCUIT COURT
MONROE COUNTY
500 WHITEHEAD STREET
KEY WEST, FLORIDA 33040
TEL. (305) 292-3550

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3117 OVERSEAS HIGHWAY
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88820 OVERSEAS HIGHWAY
PLANTATION KEY, FLORIDA 33070
TEL. (305) 852-7145

May 4, 1994

Colonel Terrence C. Salt
District Engineer
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Colonel Salt:

Please be advised that at a Special Meeting in formal session on April 12, 1994, the Board of County Commissioners of Monroe County adopted Resolution No. 121-1994, authorizing the Mayor of Monroe County to provide the U.S. Army Corps of Engineers with written comments on the Draft General Reevaluation Report and Environmental Impact Statement for the proposed reconstruction of the C-111 Canal.

Enclosed please find a certified copy of this Resolution for your consideration.

Very truly yours,

Danny L. Kolhage
Clerk of Circuit Court
and ex officio Clerk to the
Board of County Commissioners

By: Isabel C. DeSantis
Isabel C. DeSantis,
Deputy Clerk

cc: Mayor of Monroe County
County Attorney
File

Mayor Jack London

RESOLUTION NO. 121-1994

A RESOLUTION OF THE BOARD OF COUNTY COMMISSIONERS AUTHORIZING THE MAYOR OF MONROE COUNTY TO PROVIDE THE U. S. ARMY CORPS OF ENGINEERS WITH WRITTEN COMMENTS ON THE DRAFT GENERAL REEVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT FOR THE PROPOSED RECONSTRUCTION OF THE C-111 CANAL

FILED FOR RECORD
94 MAY -4 AM 11:20

WHEREAS, the U.S. Army Corps of Engineers has developed a Draft General Reevaluation Report and Environmental Impact Statement for the proposed reconstruction of the C-111 Canal near Homestead and Florida City, Florida; and

WHEREAS, the proposed changes to the C-111 canal basin are being designed to significantly alter the amount of fresh water currently entering the Taylor Slough drainage basin within Everglades National Park; and

WHEREAS, reduction in the historic flow of fresh water through Taylor Slough, which flows into Florida Bay, is a significant component of the current ecological degradation being witnessed in Florida Bay, and

WHEREAS, the health of Florida Bay plays a critical role in the continued health of tourist and commercial fishing economies in Monroe County, Florida; and

WHEREAS, the health of Florida Bay also plays a significant part in defining the character of the Keys' quality of life for its citizens whose lives are so integrally intertwined with the ambient waters and marine life of the Keys; and

WHEREAS, the decline of Florida Bay is currently having a significant impact on the tourism and commercial fishing economies and the general quality of life in Monroe County, Florida.

BE IT RESOLVED BY THE BOARD OF COUNTY COMMISSIONERS OF MONROE COUNTY, FLORIDA, that:

- the Mayor of the Board of Commissioners is authorized to provide the attached letter as the official comments of the Board regarding the C-111 Reconstruction Project; and
- this letter reflects the Board's vital interest in the appropriate and expeditious completion of this project; and
- this letter also reflects the Board's strong commitment to the revitalization of the County's tourist and commercial fishing economies and general quality of life through the restoration of health to Florida Bay.

PASSED AND ADOPTED by the Board of County Commissioners of Monroe County, Florida at a special meeting held on the 12th day of April, A. D. 1994.

Mayor London	yes
Mayor Pro Tem Cheal	yes
Commissioner Freeman	absent
Commissioner Harvey	yes
Commissioner Reich	yes

BOARD OF COUNTY COMMISSIONERS
MONROE COUNTY, FLORIDA

BY: Jack London
JACK LONDON, MAYOR

(SEAL)
Attest: DANNY L. KOLHAGE, Clerk

Isabel C. DeSantis
CLERK OF THE COURT

G/W/DC/BC042412

APPROVED AS TO FORM
AND LEGAL SUFFICIENCY

BY
Attorney's Office

COUNTY *of* MONROE

KEY WEST FLORIDA 33040

12 April 1994

Colonel Terrence C. Salt
District Engineer
U. S. Army Corps of Engineers
P. O. Box 4970
Jacksonville, Florida 32232-0019

MONROE COUNTY COMMISSION'S COMMENTS: DRAFT GENERAL REEVALUATATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT FOR THE C-111 CANAL.

Dear Colonel Salt:

The paramount concern and commitment of the Board of Commissioners and citizens of Monroe County to the issues surrounding the demise and resurrection of Florida Bay was evident at the recent public hearings held by the Army Corps of Engineers in Homestead. Monroe County represents a small fraction of the population of south Florida, a mere 78,000 residents, and yet more half of those in attendance wore the orange Tee Shirts pronouncing, "No Bay.....No Jobs!"

We thank the Corps of Engineers for its current intensified effort and shared commitment to the restoration of the Everglades Ecosystem and, particularly, Florida Bay. We equally appreciate your continued efforts to restore flows to Taylor Slough and Florida Bay and the opportunity to comment on your current plans to do so.

I. Monroe County has the following concerns and objectives regarding Florida Bay and the C-lll canal:

1. Florida Bay is a critical economic and environmental resource for Monroe County. A vast segment of the County's $2 Billion annual tourist economy and $90± million annual fishing economy depend upon the ecological health of Florida Bay. In addition, real estate values and tax revenues in Monroe County depend upon environmental health, which is what draws people to the Keys.

Tourism

- Over 6.2 million tourists visited the Keys in 1990.
- Tourists spent over $787 million in 1991 in Monroe County.
- The tourist economy, which depends on clean marine waters, healthy reefs, and abundant fish life, employed 18,000 people in 1990.
- In 1992 the Hotel/Motel industry generated $314 million in gross sales.
- In 1992 the Hotel/Motel industry generated over $18 million in yearly sales taxes in Monroe County.

Commercial Fishing

- The commercial fishing industry represents an important source of revenue for Monroe County; in 1990, commercial fisherman landed 19.7 million pounds of finfish, shellfish, and other aquatic organisms.
- 1990 dockside landings were valued at over $48.4 million. This corresponded to over $90 million in total economic activity generated by the industry.
- The commercial fishing industry produces over 20% of the statewide total for at least 12 economically important species.

- There are 3,550 commercial vessels, 3,294 saltwater products licenses, 83 wholesale seafood dealers, 155 retail seafood dealers in Monroe County.

- The 1991 pink shrimp landings in Monroe County dropped by almost 80% from 1981 levels (from 15,773,173 pounds landed in 1981 to 3,267,315 landed in 1991) resulting in the collapse of the pink shrimp industry. The nursery grounds for pink shrimp lie within Florida Bay.

Real Estate

- The Real Estate Industry, which depends on a healthy Florida Bay and Reef System to sell properties, in 1990 generated over $150 million in purchase loans.

- The current volume of real estate sales in Monroe County exceeds $250 million annually.

- Mortgage loan closings presently exceed $400 million per year.

- Public revenue, in the form of state intangible taxes and documentary stamps, generated annually from real estate closings presently exceeds $2.5 million.

2. Florida Bay is undergoing an ecological collapse.

- At least 83,000 acres of seagrasses, which provide food and shelter for fish and shellfish, have died in the past 6 to 7 years.
- Algae blooms fueled by the seagrass die-off, have clouded the Bay's clear waters and have extended as far as the Florida Keys coral reef tract, compounding the damage and affecting fishing and diving interests there.
- Millions of sponges have died recently, as a result of algae blooms, eliminating habitat for commercially valuable spiny lobsters, other invertebrates, and juvenile fish.
- Sediments underlying the currently denuded sea bottom are re-suspended continuously under virtually all wind conditions, not just during storm events.
- Salinities and temperatures have become uncharacteristically high and exhibit less seasonal fluctuation than is typical, an unhealthy circumstance.

- Oxygen levels frequently plummet and are, now, typically lower than average. This forces respiration in normally photosynthetic algae and remaining seagrasses. The condition also promotes more and more frequent fish kills.

Among other causes, a lack of historical fresh water inputs to Florida Bay ranks prominently in the demise of this formerly rich ecosystem.

3. The restoration of Florida Bay must be a paramount objective for the Army Corps Engineers in their management of fresh water and the network of conveyance canals on the mainland. Monroe County's economic health and quality of life depend on it.

4. There is a scientific consensus that the restoration of clean, nutrient and pesticide free, fresh water flows to Florida Bay is an action that can be taken ***NOW*** to help restore vitality to Florida Bay. Until recently, flows have been systematically reduced by as much as 80% over the past fifty years as the result of the Army Corps' construction and management of the South Florida water conveyance system. As a result of these past actions, Florida Bay has been changed from an estuary into a hypersaline lagoon.

5. The C-111 canal system is a critical part of the canal system that now controls flows to Florida Bay. This canal system has been utilized to divert fresh water away from Taylor Slough where it historically contributed to the Bay's fresh water inputs. The Corps has taken this action without considering the harm to Monroe County, simply to benefit a few land owners in south Dade County. This policy and action must be reversed.

6. In addition, the C-111 has been used to release huge quantities of fresh water into Manatee Bay and Barnes Sound during periods of intense rainfall. The unnatural slugs of fresh water have resulted in fish kills, destruction of benthic resources, and have resulted in significant harm to the residents of Monroe County. Once again, the Corps has taken these actions to provide drainage to a few landowners in south Dade County.

7. New plans for the C-111 canal system must reverse these damages to Monroe County. The new plans must advance the restoration of fresh water flows to Florida Bay, eliminate the harmful discharges to Manatee Bay, and must be formulated to account for their impacts to the economy of Monroe County.

II. Specific comments on the Army Corps' preferred alternative for reconstruction of the C-111 canal System.

1. The economic impacts of the C-111 reconstruction plan on the future economy and environmental health of Monroe County have not been taken into consideration. This is a serious short coming in the Corps' planning. The Corps' actions regarding the C-111 canal have seriously impacted the economy of Monroe County in the past and the plan is woefully incomplete without this analysis.

2. The preferred alternative, Plan 6A, is a step in the right direction, but it does not go far enough in satisfying the preceding concerns and objectives. The analyses and computer models from Everglades National Park, as well as, from the Corps itself, indicate that the preferred plan will make modest advances only in restoring fresh water levels in Taylor Slough, and thus, Florida Bay. It will not return historic levels of flow to the Bay.

3. Monroe County supports the following specific components of Plan 6A:

- Acquisition of the lands west of the L-31/C-111 canals, known as the "Frog Pond" and the "Rocky Glades Agricultural Area." Keeping these lands dry enough to farm causes huge losses of fresh water from Taylor Slough and Florida Bay, causing damage to the interests of Monroe County.

- Establishment of the retention/detention areas west of L-31, with pumps and structures to deliver water westward into Taylor Slough.

- Backfilling of the C-109 and C-110 canals with 9-10 plugs in each.

- Building a 1,000 foot bridge across State Road 9336 (the road leading to Flamingo) at the Taylor Slough crossing, to replace the current inadequate bridge and culverts.

These structural and land use changes will benefit Florida Bay by increasing water levels and flows in Taylor Slough, and thus, fresh water flows to Florida Bay.

4. Monroe County requests that the following changes in the preferred plan (6A) be evaluated and implemented if deemed to be effective in improving conditions in Florida Bay:

- Replace the proposed C-111N spreader canal with a water detention/retention area running east-west at the head of the C-111 basin. The detention/retention area must be located further north than the proposed spreader canal, in order to reestablish fresh water flows and deliver maximum benefits to these coastal wetlands. The retention/detention area must extend across US-1 in order to re-establish fresh water flows into the impounded wetlands between US-1 and Card Sound roads. Construct a 500 cfs pump at the S-332E location to accommodate both normal and high rainfall periods.

- Plug and backfill the existing C-111 canal below the S-18C structure and eliminate the S-197 structure. The C-111 canal must ***NEVER AGAIN*** be used to discharge flood waters to Manatee Bay. Construction of the retention/detention area described above, and the larger pump, will give operational flexibility to manage high rainfall periods.

- In the long-term and with a look to the Big Picture, the retention/detention area west of the L-31 canal and levee must be extended northward to the Tamiami Trail. The productivity and health of Florida Bay will be completely restored only if more fresh water is delivered to Everglades National Park as a whole, and therefore, Taylor and Shark River Sloughs, from Water Conservation Area 3 (WCA 3). Currently we "rob Peter to pay Paul" within Everglades National Park and south of the Tamiami Trail, when delivering more water to Taylor Slough. The coordinated rise in water levels within both Sloughs, with a consideration of quantity, quality, and hydro-period, is ultimately essential to the restoration of health to Florida Bay.

- These changes to the preferred plan will help to eliminate the adverse impacts that Monroe County currently feels in the administration of water conveyance and management in the C-111 basin.

5. Finally, Monroe County requests that the Army Corps of Engineers accelerate the schedule for the implementation of the preferred plan. The crisis in Florida Bay is too urgent, a compressed schedule must be developed and implemented. The Corps must request funds from Congress for Fiscal Year 1995

to begin implementation of the preferred plan, inclusive of the modification requested above.

On behalf of the citizens of Monroe County, whose livelihoods are so integrally tied to the health of Florida Bay, the Board of Commissioners is heartened to see the strength of the Corps' current efforts to restore the Everglades Ecosystem, and Florida Bay as a part of it. We implore the Corps to look more closely at the down stream impacts created from its past actions in the Everglades. These impacts are felt most strongly in the Keys. We appreciate the opportunity to address our concerns both for the impacts of Florida Bays' demise on our economy and on your efforts in the C-111 basin to resurrect Florida Bay. We look forward to future participation in this vital process.

Sincerely,

Jack London

Mayor Jack London
Monroe County Board of Commissioners

G/W/DC/BC042411

Working for the Nature of Tomorrow®

NATIONAL WILDLIFE FEDERATION

Southeastern Natural Resources Center
1401 Peachtree Street, N.E., Suite 240, Atlanta, GA 30309
(404) 876-8733
FAX (404) 892-1744

April 14, 1994

Colonel Terrence Salt
U.S. Army Corps of Engineers
Jacksonville District
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Colonel Salt:

The National Wildlife Federation (NWF) appreciates your leadership in helping to restore the Everglades ecosystem. As you know, NWF is the nation's largest conservation education organization. Founded in 1936, the Federation works to conserve natural resources and to protect the Earth's environment. NWF has approximately 48,000 Florida members committed to the protection and management of wildlife habitat. The Corps' Canal 111 proposals, put forth in the February 1994 Draft Integrated General Reevaluation Report and Environmental Impact Statement (GRR/EIS), represent a significant step towards restoring sheetflow in the Everglades, an essential component of any Everglades restoration plan.

The Draft GRR/EIS offers a significant improvement over both present conditions in the area and previous Corps proposals. The proposed retention/detention area will significantly contribute toward improving flood protection, creating a water barrier between the Everglades and developed lands, and providing clean water. While we agree with your recommendation to support Alternative 6A, we believe Alternative 6A could be improved in several ways:

1. The Corps should expand the retention/detention area north to Tamiami Trail (as suggested in Alternative 8) and south along C-111 through Frog Pond and past the Park entrance road (as suggested in Technical Report SFNRC 93-4). This would offer better flood protection, create more capacity for capturing runoff from developed areas, and allow for better timing of released water into Everglades National Park, while

reducing seepage out of the Park through Northeast Shark Slough.

2. In order to maximize ecological restoration of the Rocky Glades area and the headwaters of Taylor Slough, the Corps must create an open-ended spreader canal between C-111 and S-332. This would re-create sheetflow across the headwaters of Taylor Slough in a manner most consistent with historic flow.

3. We recommend the addition of the following measures to re-create historic flow patterns in the southern part of the system:

   - Place the C-111N canal as far north as possible and link it with the retention/detention area. This is important for restoring flows and spreading flood waters.

   - Use a pumping capacity of at least 500 cfs between the Rocky Glades/Frog Pond retention/detention area and the C-111N extension, in order to provide operational flexibility to remove flood waters from the C-111 basin.

   - Remove the portion of C-111 south of S-18C as an active canal to restore sheetflow into Florida Bay and to eliminate the risk of fish kills from pulse discharges into Barnes Sound and Manatee Bay following heavy rains.

We also recommend that you consider the opportunity cost of the "No action" Alternative in order to obtain a more accurate assessment of the economic impact of the Canal 111 project. The economy of South Florida is dependant upon the environment. Commercial and recreational fishing, and diving are multi-million dollar industries that could not survive the further degradation of Florida Bay. The value-added to Florida's economy by these business ventures provides further economic justification for this project.

The acquisition of the Rocky Glades and Frog Pond areas are crucial to the restoration of freshwater flows into the Everglades ecosystem and Florida Bay. NWF supports the Corps' proposal to secure these sensitive areas.

Achieving hydrologic restoration of this ecosystem will require the delivery of a sufficient amount of water at the proper times to the appropriate places. To ensure that we achieve the ultimate goal of ecological restoration, the Corps' meets its flood protection obligations, and to provide project flexibility, we recommend that the Corps take these specific actions:

- Undertake a complete review and evaluation of all historical and current information, to better define natural ecological functions for the affected area;

- Develop a fine-scale natural systems model capable of providing an estimate of pre-project hydrologic conditions, to measure the success of the Canal 111 Project; and

- Create a comprehensive hydrologic and biologic monitoring program, to fully evaluate the relative success of initial structural and operational modifications.

Thank you for taking this major step forward to restore the Everglades/Florida Bay. We look forward to your continued leadership regarding this unique and important ecosystem.

Sincerely,

Carolyn Waldron
Director

ENVIRONMENTAL DEFENSE FUND

California Office
Rockridge Market Hall
5655 College Ave.
Oakland, CA 94618
(510) 658-8008
Fax: 510-658-0630

COMMENTS OF THE ENVIRONMENTAL DEFENSE FUND

CONCERNING

THE DRAFT INTEGRATED GENERAL REEVALUATION REPORT

AND ENVIRONMENTAL IMPACT STATEMENT FOR

CANAL 111 (C-111), SOUTH DADE COUNTY, FLORIDA

Submitted by:

Rodney M. Fujita, Ph.D

Senior Scientist

April 14, 1994

The Environmental Defense Fund (EDF) is a non-profit, non-governmental organization that uses science, law, and economics to solve environmental problems. EDF has 6 offices and 250,000 members nationwide. Rodney M. Fujita is a marine ecologist with special expertise in water quality assessment and protection. Dr. Fujita has led EDF's efforts to protect the marine ecosystems of the Florida Keys since 1988.

EDF has a deep interest in protecting and restoring the integrated ecosystems of South Florida, a biologically rich and productive system extending from the Caesium Basin to the barrier reefs of the Florida Keys. EDF attorneys have played an important role in developing solutions to the problem of nutrient pollution originating from agriculture in the Everglades. EDF staff have also been actively stimulating ecosystem restoration efforts focused on the restoration of a more natural pattern of water flow through the integrated landscape and seascape of South Florida. EDF has also long been active in efforts to protect and restore the

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1875 Connecticut Ave., N.W., Washington, DC 20009, (202) 387-3500
1405 Arapahoe Ave., Boulder, CO 80302, (303) 440-4901
128 East Hargett St., Raleigh, NC 27601, (919) 821-7793
1800 Guadalupe, Austin, TX 78701, (512) 478-5161

coral reefs (and associated marine ecosystems) of the Florida Keys. EDF helped draft legislation establishing the Florida Keys National Marine Sanctuary, and has been active in the development of the Sanctuary's comprehensive management plan. Because the restoration of good water quality is key to the restoration of the ecosystem as a whole, EDF has focused on the development of a meaningful and enforceable water quality protection plan.

GENERAL COMMENTS ON DRAFT THE INTEGRATED GENERAL REEVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

EDF concurs with the regional goals and success criteria established in the Science SubGroup Report (pp. 30-31): reinstatement throughout the system of natural hydroperiods and sheet flow as approximated by natural system models; reestablishment of predrainage wading bird nesting colony locations and timing of nesting; no further wetland losses; restoration of degraded wetlands; wetland use permits stipulating requirements for enhanced hydrologic connectivity, water quality, and water storage; improved recruitment of fishery and nonfishery species; increased fish abundance and reinstatement of species in pre-disturbance locations; reduction in mercury body burdens in top carnivores; reduction of contaminants in sediments; increases in native faunal diversity; reduction in deformed fish in estuaries; reappearance of missing vegetative landscapes; elimination of nutrient tolerant and exotic plant species; a periphyton community characteristic of oligotrophic, natural hydroperiod systems; and increases in the populations of threatened and endangered species. More specific objectives and strategies for achieving these goals are sketched out in the Science SubGroup Report. Changes in the structure and functioning of the C-111 project have important implications for Florida Bay and the marine ecosystems of the Keys. EDF supports the hydrologic and ecological restoration objectives and strategies for coastal areas, Florida Bay, the Florida Reef Tract, and the Florida Keys to the Dry Tortugas described in the Science SubGroup Report (pp. 63-71). EDF believes that these goals and strategies to achieve them are consistent with the replacement of unsustainable, damaging economic activity (farming in former wetlands subject to flooding) with sustainable, high-value, environmentally responsible economic activities (commercial and sport fishing, tourism, etc.).

EDF supports the general intent of the proposed C-111 project modifications: to restore the hydrology of the C-111 basin and Taylor Slough to a more natural pattern of freshwater input, depth, and timing. However, while it seems clear that Alternative 6A (the recommended alternative) will provide the greatest ecological benefits, **EDF cannot recommend adoption of any of the alternatives for the C-111 project at this time** because changes in operational criteria to be associated with these criteria have not yet been specified.

EDF concludes that all of the alternatives described in the Integrated General Reevaluation Report and Environmental Impact Statement (IGRR/EIS) are likely to fail to achieve important goals set out by the Science SubGroup for the region (pp. 57-71). Impacts of the alternatives, both positive and negative, on listed and endangered species are expected to be insignificant; hence, the goal of expanded populations of these species will probably not be achieved. The goal of restoring natural fire regimes will not be met under any of the proposed alternatives. Beneficial impacts on water quality are only speculated upon in the IGRR/EIS. **Because increased flows of nutrient-enriched water to Florida Bay have the potential to be very damaging, it is imperative that the factors that have been contributing to noncompliance with water quality standards in the region be established and controlled to ensure that nutrient (and other pollutant) concentrations in all water released into the Bay are close to pristine levels.**

SPECIFIC COMMENTS

Page 2-11. Phosphorus levels at S-332, S-175, and S-18C are low but have been increasing in recent years, frequently exceeding target levels. Best management practices to reduce nutrient loadings from known anthropogenic sources that discharge to Outstanding Florida Waters and other oligotrophic aquatic systems should be implemented immediately, preferably in a way that achieves water quality goals while allowing dischargers the flexibility to choose cost-effective measures to reduce pollution. If a nutrient budget analysis of the Taylor Slough Watershed (and of the entire region that contributes water, or is expected to contribute water as ecological restoration proceeds, to Florida Bay) indicates that agriculture and other anthropogenic sources are not contributing excess nutrients or other pollutants to the ecosystem, then requirements to reduce loadings may be relaxed.

2-22. The IGRR/EIS states that regional climate is controlled by latitude, proximity to Atlantic and Gulf, and numerous inland lakes. Is it known that the regional climate has not responded to changes in vegetation and hydrologic changes? In other tropical ecosystems, massive loss of vegetation and the resulting decrease in evapotranspiration is thought to alter rainfall quanitity and patterns.

3-1 to 3-7. While reference is made (p. 3-6) to the fact that freshwater deliveries to Manatee Bay, Barnes Sound, and Florida Bay would continue in their reduced-from-historical state under the "Without Project", or base, condition, the environmental and economic implications are not adequately described. Boesch et al. (Deterioration of the Florida Bay ecosystem: An Evaluation of the Scientific Evidence, Report to the Interagency Working Group on Florida Bay, sponsored by the National Fish and Wildlife Foundation, the National Park Service, and the South Florida Water Management District, 1993) conclude that disruption of the natural timing and quantity of freshwater flow has resulted in the destruction of wetlands and other types of fish and wildlife habitat in the transition zone between the Everglades and Florida Bay. Furthermore, the base condition would include a continuation of the drainage of large volumes of water away from Shark River Slough, a major source of freshwater to Florida Bay. Therefore, the "Without Project" condition would be expected to result in the continued degradation of transition zone habitats and perhaps of the Bay as a whole, along with greatly reduced fish recruitment and wildlife abundance. Since Florida Bay habitats are crucial in the life cycles of the species that support most of the region's commercial fisheries, the "Without Project" conditions would also result in continued economic harm to fishermen, the sportfishing industry, and the tourism industry, and would seem likely to increase harm, as the ecological collapse of Florida Bay and the integrated coastal ecosystems of the Bay and the Keys deepens. Continued seagrass dieoff and/or lack of seagrass recolonization, with associated algal blooms and turbidity, will likely result in continued loss of coral cover, sponge die-offs, and other adverse changes in the integrated estuarine and marine ecosystems of the region.

5-6. Evaluation factors for alternative plans should include, in addition to environmental benefits, economic benefits associated with the restoration of natural ecosystem structure and function -- e.g., commercial and sport fisheries, tourism, quality of life associated with clear waters in Florida Bay and the Keys, etc.

5-7. The environmental benefits of mangroves, fringing marshes, seagrass meadows, and other components of the integrated estuarine and marine ecosystems of Florida Bay and the Keys are not included in the evaluation criteria.

8-13. The IGRR/EIS states that "to compare total benefit-to-cost ratios without including environmental benefits would be misleading". We concur, and believe that the IGRR/EIS leads the reader to make such misleading comparisons because it lacks an adequate discussion of the environmental and economic costs of no action and of the environmental and economic benefits of restoration.

5-49-50. Table 5-4 indicates that the three alternatives that have the greatest potential to provide large ecological improvements (4, 6, and 6A) would be all be associated with a major negative effect on regional income due to the loss of agricultural lands. When analyzing the costs and benefits of alternatives, it must be recognized that current practices, while resulting in agricultural revenues, also result in a much larger but unquantified amount of economic and biological harm represented by the loss of biological diversity, the loss of valuable soil (and hence, the loss of sustainable agricultural use), the loss of potential fisheries yield, the loss of sportfishing revenue, the loss of tourism income, and reductions in property value. These costs, if quantified and incorporated into the NED (National Economic Development) account, would surely outweigh the costs of ecological restoration.

Some of the economic impacts of the preferred alternative (6A) would be offset by restoration as a result of increased income from sustainable agriculture, sustainable and enhanced commercial and sport fishing, environmentally responsible tourism, and other economic activities that can occur in harmony with natural ecosystem structure and function. Continuation of the base condition (i.e., the "no action" alternative) would likely result in the collapse of the valuable commercial and sport fishing industries of Florida Bay and the Keys, adverse effects on tourism and quality of life, and incalculable harm to the Everglades and marine ecosystems of the region. According to the Science SubGroup Report (p. 2), tourism is a major industry in the region, and recreational fishing and diving are significant in the overall economy. Recreational activities and tourism account for about half of the total employment in Monroe County (the Keys). Sportfishing contributes about $77 million and diving contributes about $354 million to the Keys economy each year. These critical economic sectors are highly dependent upon the protection and restoration of biological diversity, ecosystem integrity, and water quality. While a rigorous comparison of the net economic benefits of the preferred alternative is not possible at this time, the more natural ecosystems and sustainable economic activities associated with ecological restoration are highly preferable to the continued catastrophic loss of natural resources and unsustainable agriculture that would be associated with no action.

6-2 to 6-4. The preferred alternative (and indeed all of the alternatives) are expected to have little or no effect on threatened and endangered species. Restoration should result in increased abundance of such species.

7-9. Prescribed burning will continue in the lands acquired for restoration. EDF concurs with the conclusions of the Science SubGroup Report (p. 13) that the replacement of the natural fire regime with prescribed burning which dampens variation can lead to the loss of biological diversity. Species tend to be adapted to natural variations. Dampening these variations would be expected to result in selection for certain species and elimination of others.

METROPOLITAN DADE COUNTY, FLORIDA

METRO-DADE

METRO-DADE CENTER

OFFICE OF COUNTY MANAGER
SUITE 2910
111 N.W. 1st STREET
MIAMI, FLORIDA 33128-1994
(305) 375-5311

Colonel Terrence Salt
United States Army
Corps of Engineers
Jacksonville District
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Colonel Salt:

On April 19, 1994, the Dade County Commission will act on a proposal to spend $25 million to acquire land in the upper Southern Glades area of the C-111 basin and in the Model Lands Basin. The South Florida Water Management District has already acquired more than 28,000 acres in the Southern Glades and has pledged an additional $25 million for land acquisition in these areas (see attached map). Because of these commitments, we are especially concerned that the acquisition areas may become drier if the preferred alternative 6A described in the February 1994 draft Integrated General Reevaluation Report (GRR) and Environmental Impact Statement for Canal 111 in South Dade County, Florida is implemented.

We are also very concerned that the GRR does not thoroughly evaluate all of the proposed alternatives in the context of the entire C&SF Project and that no modeling was presented for the preferred alternative. The modeling results presented in the draft overstate the benefits to be derived and understate negative impacts that may occur elsewhere in the southern Everglades system, because the model assumed that the system would be operated at design stages even though the system has rarely been operated to maintain the authorized design stages.

Dade County believes that any effective solution to water shortages in Taylor Slough, the eastern panhandle and coastal estuaries must involve the reintroduction of more water into the southern Everglades from Lake Okeechobee and its outlets. Without such assurances, engineering solutions such as the preferred alternative, will merely redistribute artificially deficient water resources during periods of water shortages to the potential peril of other important natural resources such as Biscayne National Park and the possible detriment of domestic and agricultural users in south Dade County.

Dade County requests that: (1) a binding commitment be made to divert more water from Lake Okeechobee and the northern Everglades to the southern Everglades to ensure that the potentially detrimental effects of this project do not materialize; (2) Dade County become an active participant in the development of operational criteria for all of the structures in the C-111 Basin; (3) the alignment of C-111N be moved as far north as possible in the Southern Glades acquisition area with a culvert connection to the Model Lands area; and (4) C-111N be supplied through a 500 cfs pump rather than the 50 cfs pump shown in alternative 6A.

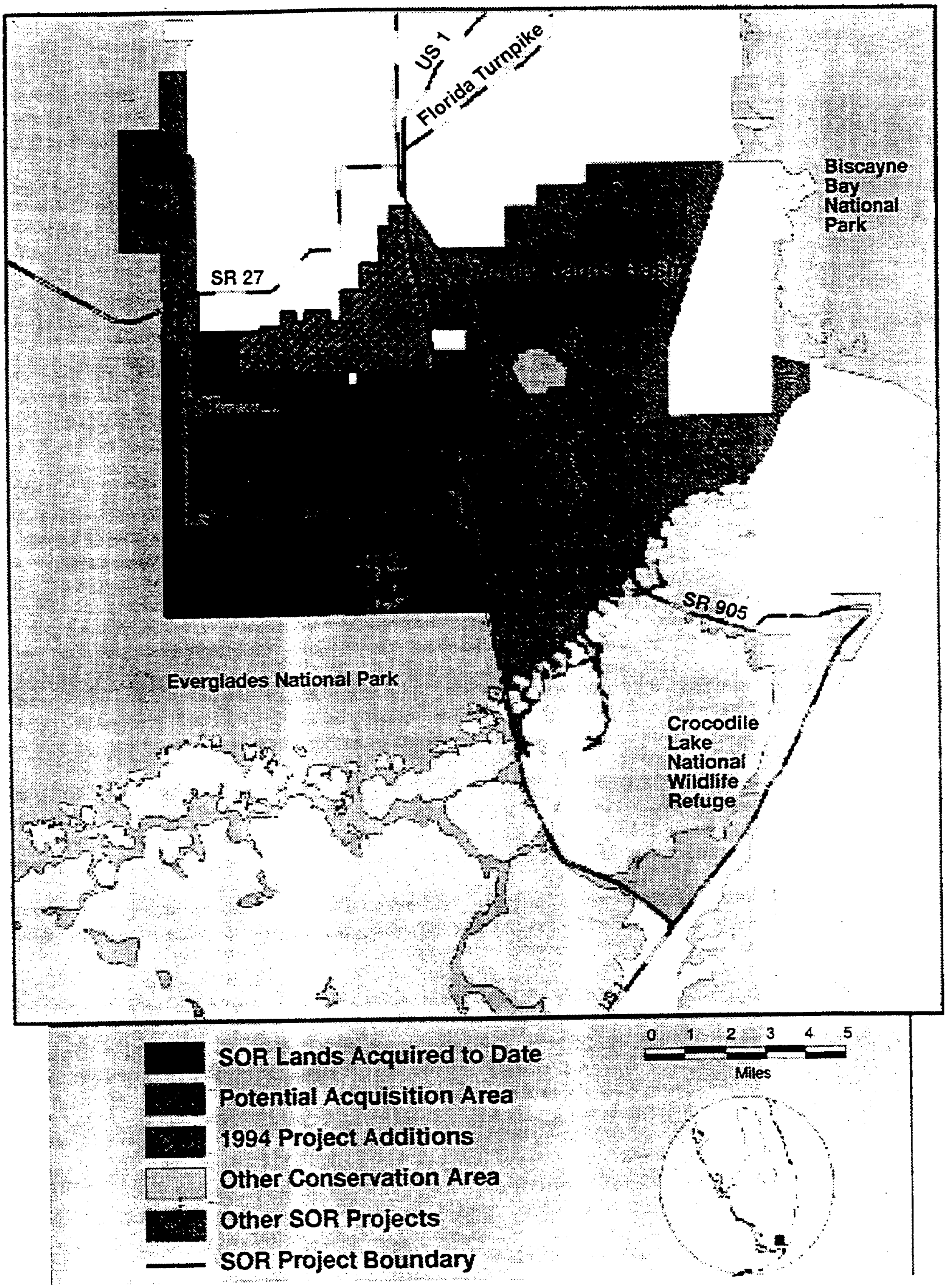
Please refer to the attached report for additional information regarding these comments and recommendations. If you have any questions about this letter or the attachment, please contact Ms. Jean Evoy at (305) 375-2835.

Sincerely,

Joaquin G. Aviño, P.E., P.L.S.
County Manager

Attachments

CC: Chairman and Members, Board of County Commissioners
Chairman and Members, South Florida Water Management District Board
Mr. Richard Ring, Superintendent, Everglades National Park


US 1
Florida Turnpike
Biscayne Bay National Park
SR 27
SR 905
Everglades National Park
Crocodile Lake National Wildlife Refuge
US 1
SOR Lands Acquired to Date
Potential Acquisition Area
1994 Project Additions
Other Conservation Area
Other SOR Projects
SOR Project Boundary
0 1 2 3 4 5
Miles

Biscayne National Park and the possible detriment of domestic and agricultural users of the Biscayne Aquifer in Dade and Monroe Counties. We also concur with the statement made by Everglades National Park in its Technical Report SFNRC 93-4, "Operational criteria must be locked in as part of the entire process, otherwise the preferred alternative may not work for most of its intended purpose (viz. the L-31W canal)."

Dade County is also concerned about projected decline in hydroperiods and water levels that are shown for the Upper Eastern Panhandle under alternative 6. We assume that the impacts of the preferred alternative 6A would be similarly negative. Over 28,000 acres of this area has been acquired by the South Florida Water Management District for the purposes of restoring sheetflow to SE Everglades National Park and NE Florida Bay and contributing to the survival of freshwater and marine communities. The Metro-Dade Board of County Commissioners has pledged to share the cost of purchasing lands in the northern portion of this area and in the Model Lands Basin east of US 1 through its Environmentally Endangered Lands Program. The total acquisition cost is estimated to be $50 million.

The preferred alternative includes a canal that would sever the lands that are being purchased and a 50 cfs pump that would divert only a small fraction of the water that is projected to flow south through C-111. Under the preferred alternative, lands north of the proposed canal and levee would become drier and the already serious problem of exotic vegetation control would be exacerbated. Dade County concurs with the National Audubon Society and other members of the Everglades Coalition that it would be preferable to divert floodwaters further to the north into the exotics dominated area. The County also supports the National Park's and the Coalition's recommendation that a 500 cfs pump be installed to divert floodwaters east from C-111 and to make the portion of C-111 south of S-332E essentially inoperable.

Since the C-111 GRR Study Area includes the triangle between US 1 and Card Sound Road, Dade County requests that the Corps reconsider extending the C-111N canal through a culvert, or series of culverts, under US 1 into the Model Lands Area. This would begin the process of reconnecting the lands that span the southern Everglades. This portion of the Model Lands functions as a recharge area for maintaining the salt barrier line and for the discharge of freshwater into Barnes Sound and Manatee Bay which are directly contiguous to NE Florida Bay.

Dade County could support the highly engineered approach to enhancing water deliveries to the upper Taylor Slough described in the preferred alternative, if we could be assured that the authorized canal levels will be maintained in the L-31N and C-111 canals and that hydroperiods and water levels will not be decreased in the Southern Glades SOR Lands and North C-111 acquisition areas.

Dade County requests that: (1) a binding commitment be made to divert more water from Lake Okeechobee and the northern Everglades to the southern Everglades to ensure that the potentially detrimental effects of this project do not materialize; (2) Dade County become an active participant in the development of operational criteria for all of

METRO-DADE COUNTY COMMENTS ON THE C-111 GRR

Metro-Dade County staff have reviewed the February 1994 draft Integrated General Reevaluation Report and Environmental Impact Statement for Canal 111 in South Dade County, Florida. Dade County has gone on record on several occasions in support of Everglades restoration efforts, however, we have several concerns about the preferred alternative presented in this draft document.

It is unfortunate that the limited timeframe and scope of this GRR do not allow for thorough evaluation of all proposed alternatives, especially the preferred alternative, in the context of the entire C&SF Project. No modeling of the preferred alternative 6A or Everglades National Park's alternative 8 is included in the February draft. Alternatives 1, 2 and 3 were modeled using authorized project design stages while alternatives 4 through 6 were modeled using a rating curve for S-176, based on flow in lieu of actual stage data, and authorized stages for structures S-174, 175 and 332 where they were included in the alternative. The hydroperiod and water depth differences between each of the alternatives and the base condition assumed that the structures in the base condition were operated at their authorized design stages. This is cause for skepticism, because the South Dade Conveyance has rarely been operated as it was designed. In fact, the headwater at S-176 was actually at the authorized design stage on only <u>two days</u> in the entire four year period between January 1990 and March 1994.

The modeling results included in the draft may substantially overstate the benefits to be derived and understate potentially negative impacts elsewhere in the system, if canal stages are not be maintained at optimal levels. This concern is heightened by the fact that S-332 B, C and D in the preferred alternative are designed to pump when water levels in L-31N range from 3.0 to 6.5 feet. Before Dade County can support this project, we need to know how often canal stages can be expected to drop below the 5.5 optimum design stage in the segment of L-31N between S-331 and S-176 if the preferred alternative is implemented, the assumptions on which this estimate is based and how these proposed pump stations will be operated when canal stages fall below 5.5 feet.

In Appendix A, the draft document acknowledges that "Water availability was limited to basin rainfall, existing S-331 water supply releases and seepage inflows from Shark River Slough restoration of Modified Deliveries to Everglades National Park. Lack of available water severely limited the alternatives from reaching their full restoration capabilities".

Dade County believes that any effective solution to water shortages in Taylor Slough, the eastern panhandle and coastal estuaries must involve the reintroduction of more water into the southern Everglades from Lake Okeechobee and its outlets. Without such assurances, engineering solutions such as the preferred alternative, will merely redistribute artificially deficient water resources during periods of water shortages to the potential peril of other important natural resources such as the structures in the C-111 Basin; (3) adequate sheetflow be provided across the eastern panhandle area by diverting floodwaters into C-111N, which should be constructed in the exotics dominated areas in the upper portion of the Southern Glades acquisition area rather than the alignment shown in alternative 6A; and (4) C-111N be supplied with a 500 cfs pump rather than the 50 cfs pump included in alternative 6A.

04/18/94 08:13 OPM - REGION IV PF 001

OPTIONAL FORM 99 (7-90)

FAX TRANSMITTAL # of pages ► 5

To Col Salt	From Gerald Miller
Dept./Agency	Phone # 404/347-3776
Fax # 904-232-3442	Fax # 404/347-5206

NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

UNITED STATES ENV

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ATL

APR 15 1994

Colonel Terrance A. Salt
District Engineer, Jacksonville
P.O. Box 4970
Jacksonville, FL 32232

Attn: Mr. Stephen Sutterfield
Planning Division

Subject: Draft Environmental Impact Statement (DEIS) for Canal 111 (C-111), South Dade County (Central and Southern Florida Project for Flood Control and Other Purposes)

Dear Colonel Salt:

Pursuant to Section 309 of the Clean Air Act and Section 102 (2)(C) of the National Environmental Policy Act (NEPA), EPA, Region IV has reviewed the subject document which discusses the environmental consequences of an array of structural and non-structural modifications to existing works in the C-111 basin.

The former measures include the construction or modification of ten canals, building the L-31/S-332D tieback levees, upgrading the S-332D bridge which connects Taylor Slough (TS) with the Everglades National Park (ENP), installing five 300 cfs pumps, and removal/reuse of excavated material along the southerly leg of C-111. Non-structural components of the plan include acquisition of over 11,000 acres of land in the Frog Pond and Rocky Glades and relocation of some residential structures which would be adversely impacted by project implementation.

These actions will be accomplished in an attempt to restore certain functional elements of the TS and eastern ENP ecosystems which have been negatively affected by the ongoing construction of numerous flood control projects in the C-111 Basin. Critical to TS restoration is the reconstitution of the seasonal overflow of water from Shark River Slough (SRS). Additionally, the project works should remove 40% of the standard flood runoff from the subject drainage area, reduce depth/duration of larger floods, provide water control to prevent overdrainage, prevent saltwater intrusion, and provide facilities to convey up to 500 cfs to ENP when normal runoff is available.

While certain of the construction activities, e.g., tie-back levees, necessary to accomplish these ends will create some significant localized environmental impacts, we agree that the long-term benefits justify the short-term losses. Eventually it is anticipated that a compromise solution will evolve which will provide both flood protection and a means to increase management options to benefit the natural environment.

Alternatives 4, 6, and 6A will all raise water in SRS to a degree; however, this objective can only be achieved when rainfall is adequate and judicious water management is undertaken. Only then will a somewhat natural overflow condition result. Among these alternatives EPA strongly supports 6A since it has the greatest flexibility to restore natural timing, location, and volume of water to the major TS subdivisions. Moreover, it achieves these results with no significant increase in comparative cost over project life.

The interposing buffer areas are a significant beneficial aspect of 6A. They should physically lessen seepage back into the canals as well as assimilate some of the phosphorous which has created a significant problem in the basin. Appropriate management of these buffer areas, therefore, will be very important. Of course, the other major design elements of 6A will alter the water budget in the Rocky Glades and Frog Pond to an important extent. This change will adversely affect agricultural endeavors located there which is one of the forcing functions for the legislation authorizing their purchase.

On the basis of our review we would like to commend all the parties which assisted in developing the overall plan and the supporting documents. The use of ongoing scoping throughout the planning phase was an innovative way to insure that all the important issues in this complicated project were included. Nonetheless, the amount of effort required to compile all this information, make a cogent assessment of how all the pieces mesh together, and present the data in a coherent fashion was obviously a major undertaking. We appreciate that many of the project goals will only be realized after a period of time and may differ somewhat from initial projections.

Therefore, we have assigned a rating of EC-1 to the document, per se. That is, we have a degree of environmental concern about how all the project elements will ultimately function and more importantly the number of refinements that will be necessary to accomplish all the desired purposes. However, we are fully supportive of 6A's objectives and the overall concept of the project. As additional details become available, it should be shared with the involved parties. A brief list of information which we believe would benefit and/or should be included in the final document is attached.

Thank you for the opportunity to comment on this action. If we can be of further assistance in this matter, Dr. Gerald Miller (404-347-3776) will serve as initial point of contact.

Sincerely,

Heinz J. Mueller

Heinz J. Mueller, Chief
Environmental Policy Section
Federal Activities Branch

Attachment

Specific Comments

o The recommended plan is a compromise which everyone hopes will accomplish the often independent objectives of flood control and environmental enhancement. The scope of the project matches the magnitude of the goals. While these environmental aims are laudable, construction of structural measures will result in some important, if localized adverse impacts. For example, borrow material for the S-332D Tieback Levee could come from existing disposal mounds along C-111 or an adjacent potential borrow canal. Disregarding cost, the former option appears to be much better than the latter, i.e., wetland enhancement is obviously preferable to wetland habitat conversion to open water.

Therefore, we suggest that during the final stage just prior to actual construction every effort be taken to make any necessary adjustments/design changes to keep these unavoidable losses to a minimum. In a related matter we urge that the staging of construction, e.g., temporary fill for access, fill pads for construction materials, etc., be carefully considered to avoid unnecessary adverse environmental impacts.

o In fact, given the scale of this proposal, we offer that wherever possible existing mounds of material from previous construction be excavated to ground level and relict borrow refilled. However, care will have to be taken in this regard to avoid providing habitat favorable for penetration of exotics.

o Best Management Practices (BMP) will be required during all construction phases for this type of project. Given the sensitive nature of the subject area, we suggest the contracts for all construction components contain substantive financial penalties for non-performance of critical BMPs. As noted, follow-up monitoring will be accomplished to insure that the agreed upon success criteria for sediment control, etc. occur and where necessary work repeated until satisfactory results are obtained.

o The five pumping stations will be powered by diesel engines to ensure reliability during electric power outages. Given the high water table and biological sensitivity of the environment around these stations, the operation/maintenance plan for the pumps and fuel systems should be carefully reviewed to insure compliance with all reasonable contingencies.

o Low berms will be created in a number of locations to satisfy hydraulic design requirements and to provide access for maintenance. These areas will have to be managed in a number of ways for vegetation control. Mowing would not be a major problem from an environmental perspective; however, the use of herbicides, especially via aerial application could be problematical. We suggest that the use of herbicides be kept to a minimum because of their unintended consequences.

o While we appreciate that cost is an important factor in decision-making relative to this project, we suggest that the acquisition of land interests in the detention/retention area be purchased in fee simple rather than just encumbered by flowage easements. The former would give greater operational flexibility in their immediate use and preclude potential renegotiation with land owners regarding future changes in value/use.

o A brief site reconnaissance will need to be conducted for the five properties which will be required for operation of the recommended alternative to insure the absence of any hazardous/toxic wastes.

GHIOTO & ASSOCIATES
Water Resources and Civil Engineering

Rodney D. Ghioto, P.E.
Owner

April 18, 1994

Transmitted by FAX
(Hard copy to follow)

Mr. A. J. Salem
Chief, Planning Division
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Subject: Comments on the Draft Integrated General Reevaluation Report and Environmental Impact Statement, Canal 111 (C-111) South Dade County, Florida.

Dear Mr. Salem:

Enclosed for your consideration is a copy of our comments regarding the February 1994 draft document. I am submitting these comments on behalf of the Florida Lime and Avocado Administration Committees and South Dade Land Corp, who together represent a very large segment of the agricultural lands affected by this project.

I hereby request that you evaluate the comments and our proposed plan in detail before sending this document to higher levels of authority. We feel that the Recommended Plan will be damaging to agriculture both east and west of the canals. We also feel that the curtain wall alternative will provide better environmental benefits while improving agricultural conditions in the area.

Sincerely,
Rodney D. Ghioto, P.E.
Rod Ghioto
GHIOTO & ASSOCIATES
Owner

cc: Mr. James Humble, South Dade Land Corporation
FLAAC
Ms. Silvia Alderman, Katz, Kutter, Haigler, Alderman, Davis, Marks & Rutledge
Mr. Brad Waller, Hydrologic Associates USA, Inc.
Mr. Pete Rhoads, SFWMD

P.O. Box 690758 • Orlando, Florida 32869-0758 • Phone (407)345-5224 • FAX (407)352-6670
7548 Municipal Drive • Orlando, Florida 32819

A REVIEW OF THE

DRAFT
INTEGRATED GENERAL REEVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT
CANAL 111 (C-111)
SOUTH DADE COUNTY, FLORIDA

February 1994

Prepared for

South Dade Land Corporation
and the
Florida Lime and Avocado Administration Committees

by

GHIOTO & ASSOCIATES
Water Resources and Civil Engineering

April 1994

Part A

Curtain Wall Alternative

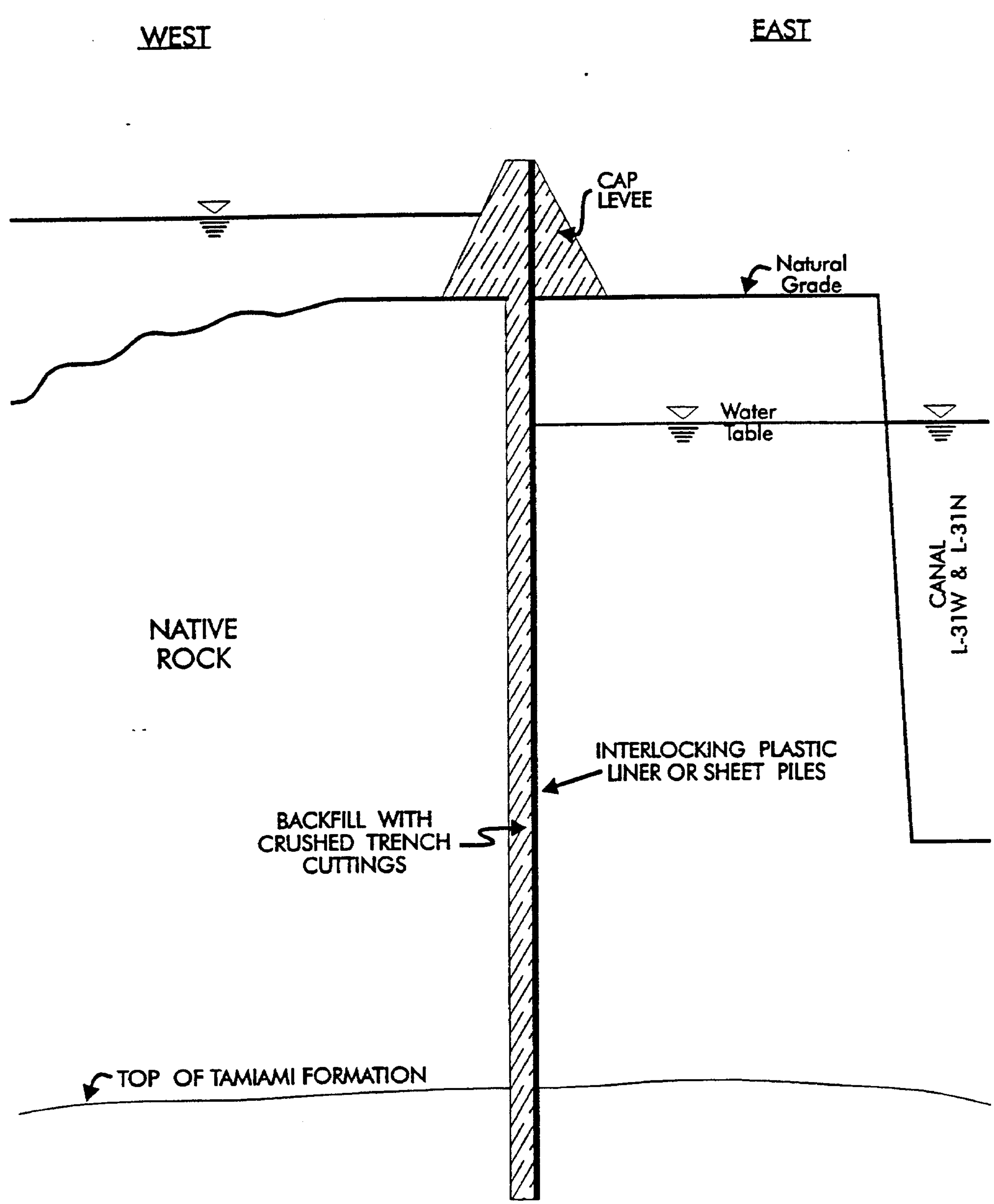
We feel that a more passive approach to reduction of water losses from the ENP and, therefore hydroperiod extension, is appropriate and potentially much more cost effective than the Recommended Plan (Alternative 6A). In fact, because we feel that the Selected Plan will cause additional damage to farm lands east of the canals, we believe acquisition of much more land or construction of a curtain wall (in addition to the Selected Plan) will need to be accomplished to ultimately resolve this problem. Our proposal relies upon the construction of a vertical flow-retarding barrier wall, fabricated from plastic, along the western edge of developed areas in South Dade County. Its purpose would be to reduce ground water losses from Northeast Shark River Slough, the Rocky Glades and the northern Taylor Slough Basin. This technology is not new and has been successfully applied all over the world, especially for the containment of hazardous materials in ground water as well as surface water bodies. It has also been used in the rehabilitation of failing flood control levees.

It has become obvious to us that this alternative is the only feasible way to achieve restoration goals. It is also the only alternative proposed that would not risk irreparable harm to up to 35 square miles of existing and unique agricultural lands. It is the only alternative that is a "win - win" scenario for all who are genuinely concerned about the health of the southern Everglades, Florida Bay and preservation of the endangered American Farmer.

The Construction Concept

Figure 1 shows a vertical section of the proposed concept. It consists of a vertical trench through the limestone with a plastic liner inserted along the eastern side of the trench face. After placement of the material, the trench would be backfilled with trench cuttings. The liner material could consist of 120 mil plastic liner material with interlocking joints. For areas where this material is not appropriate, due to small to medium sized solution cavities, a plastic sheet pile can be used instead and interlocked with the liner material if necessary. In situations where neither is appropriate, it may be necessary to leave a local gap in the curtain wall. It should be remembered that the concept consists of reducing regional flow and leakage associated with localized openings is not considered to be significant.

The liner material would extend upward into a small cap levee that would be constructed to protect areas to the east from surface flow during wet periods.



GHIOTO & ASSOCIATES Water Resources and Civil Engineering 7548 Municipal Drive • Orlando, Florida 32819	CROSS SECTION CURTAIN WALL CONCEPT	Figure 1

The footprint of this levee would probably be less than that necessary under other alternatives because it wound contain an impermeable insert. Structural integrity is needed but seepage through the cap levee itself is prevented by the liner material. Structural integrity below natural land surface is provided by the rock itself.

The section in Figure 1 shows the liner fully penetrating to the less permeable Tamiami Formation, which varies in depth from about 40 to 55 feet along the proposed alignment. However, this need not be the case because its purpose is to reduce, not stop, leakage from the park. If the concept works too well and additional easterly flow is desired, then gated culverts through the cap levee could be used to move water from west to east. In addition, it would be possible to remove panels from the curtain wall if more flow is required.

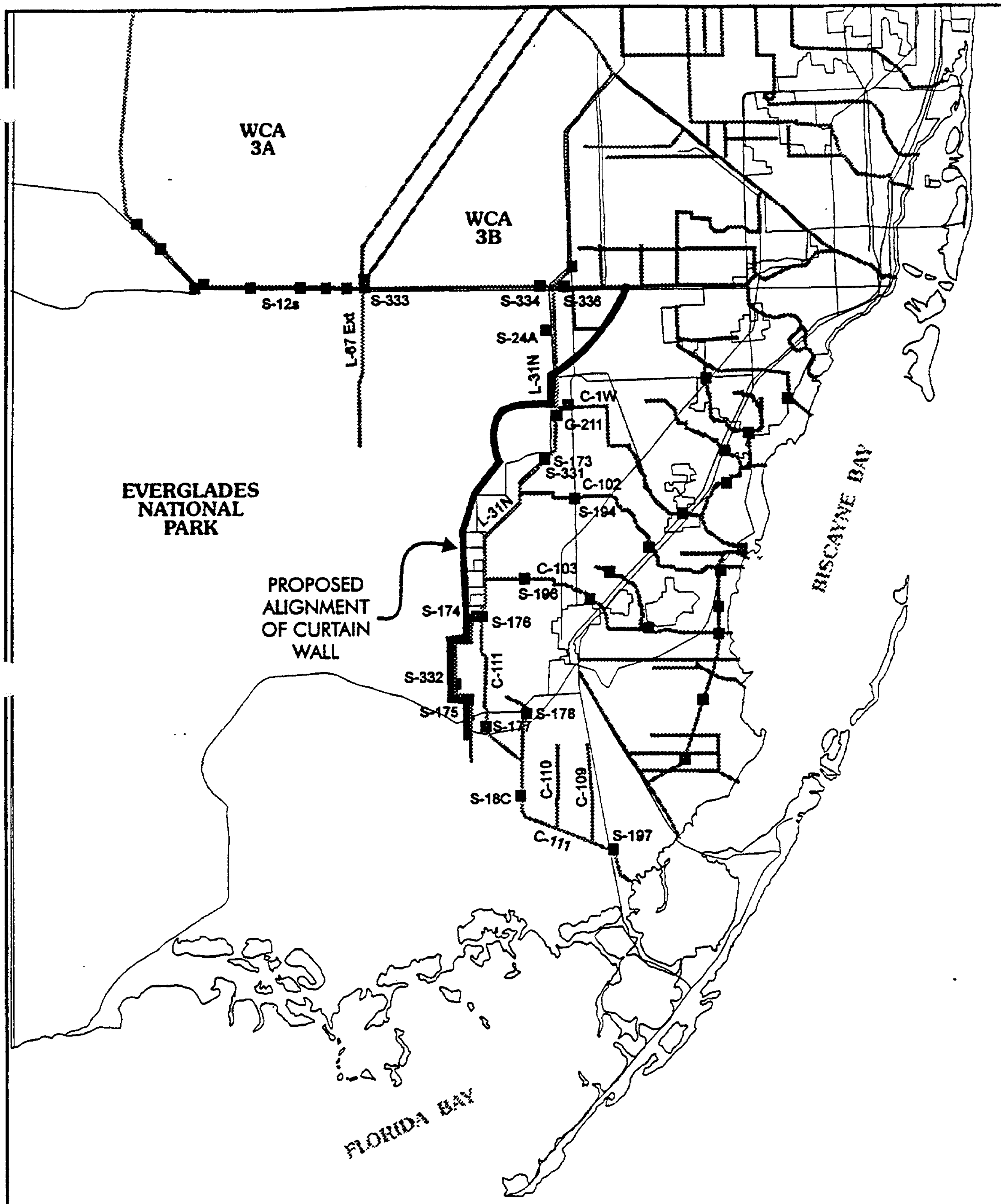
Proposed Alignment

The proposed route for this facility is shown in Figure 2. It would begin at the southern boundary of the Frog Pond and be placed along the western bank of the L-31W borrow canal. North of the Frog Pond, it would follow the same alignment as the western levee proposed in the Corps' Alternative 6. It would also follow the proposed western levee alignment around the 8.5 Square-Mile residential area to the existing the L-31N levee. Structure G-211 would be moved north of C-1W to form a new delivery location for L-31N borrow canal and to make C-1W available for flood control use. The alignment would cross L-31N at G-211 and then follow the eastern bank of the canal (northward) to a point immediately south of the remnant wetlands of the Bird Drive area. From that point, it would skirt the southern side of the wetland area in a northeastern sweep to be terminated at Tamiami Trail.

In the northern portion of the system, the remnant wetland portions of the Bird Drive area can then be re-connected to NESRS via degradation or gapping that portion of the L-31N levee, north of the relocated G-211. In addition, the restored Bird Drive area wetlands could possibly be connected to the proposed lake belt system farther north providing additional water supply to NESRS and/or to the L-31N canal to the south.

Structure S-336 can be moved eastward to coincide with the point where the curtain wall ties into Tamiami Trail. The proposed S-356 and S-357 pump stations, as well as modifications to S-334, would be eliminated from the 1992 plan for NESRS.

Pump stations can be located along the curtain wall at strategic locations to back pump under-seepage and to provide additional water supply to the ENP where



GHIOTO & ASSOCIATES Water Resources and Civil Engineering 7548 Municipal Drive • Orlando, Florida 32819	CURTAIN WALL ALIGNMENT	Figure 2

and when appropriate. Through selection of the proper vertical length of the curtain wall, eastward seepage would potentially be a small fraction of what it would be with all of the other proposed plans. Therefore, the size of the proposed pump stations could probably be significantly reduced or even eliminated.

By movement of G-211 farther north, meaningful flood protection for the 8.5 Square-Mile residential area, and other areas between G-211 and S-331, could be provided via efficient use of the C-1W canal.

S-331 and the South Dade Conveyance System could be used as originally intended, to supply water during droughts to the L-31N and C-111 basins as well as to ENP at S-332 and S-18C. However, with drastically reduced losses from the ENP, water supply at these locations could be limited to the rainfall/runoff equivalent of historic Taylor Slough areas originally removed from the basin by the project. It is also possible that, if much higher levels are obtained to the north (in NESRS), large quantities of supplemental flows directly to Taylor Slough from the east could be reduced or eliminated. The overflow from Shark River Slough would be more effective in holding up water levels.

Hydrologic Function

The primary case for restoration of Taylor Slough has been predicated on the fact that ground water outflows to the east have been increased by drainage of developed areas resulting from the C&SF Project and earlier activities of man. There is no reason to deny this because that was the original intent of the C&SF Project and it worked. The ENP has contended that this increased ground water outflow has made it impossible to maintain historic hydroperiods (i.e. higher water levels for longer periods of time) in the upper Taylor Slough area.

Water levels west of the curtain wall can be manipulated to almost any desirable elevations, over any desired locations, and for any desired period of time. This will only be constrained by the availability of water from the north (across Tamiami Trail) and local rainfall over ENP. Recent (preliminary) two dimensional modeling by the SFWMD, in the vicinity of the Frog Pond, indicates that the curtain wall would be effective in reducing outflow at that location by up to 96 percent if installed to a depth of 41 feet. These results indicate that water losses from the ENP could be controlled to a significant degree, maybe to the point where pumping to the west would not be required. It should be remembered that reducing losses of water is the same as adding more water if the goal is to maintain hydroperiod.

If westward pumping could be eliminated or significantly reduced, then implementation costs would decrease and there would be less concern over the quality of water along and within the borders of the ENP.

With the curtain wall, the agencies will be free to experiment with the restoration of NESRS and Taylor Slough at will. In addition, water levels east of the curtain wall can be maintained in a lower range so that agricultural productivity of this region can be maximized rather than stifled. The residential area would be provided with real flood protection (above the differential damages level contained in the 1992 GDM). The only land required is right of way acquisition for the cap levee and maybe a small borrow canal to the east for collection of under seepage.

One of the problems with the current thinking regarding higher water levels in canals to reduce losses from the ENP is that the steeper ground water gradients still exist to the east. As with the current test, the gradient is simply shifted from the L-31N and C-111 canals to the ridge structures, where it then steepens to the east coast. This requires additional pumping into the region to maintain that gradient, and these subsurface flows are then lost from the system. Lower water levels east of the curtain wall will flatten the eastern gradient and require much less volumetric input, via the South Dade Conveyance System (SDCS), to maintain the system.

Water Supply Function

The SDCS can function as originally intended to supply that region's well fields and irrigation needs, additional needs in the lower part of the ENP, and needs associated with the prevention of salinity intrusion. We do not need a 5.5 foot elevation at the S-176 headwater or 4.5 feet at S-177 for salinity intrusion prevention. It is emphasized that we are not proposing lowering water levels (east of the wall) to the point where there would be a salinity intrusion problem. That would be self defeating because agriculture needs fresh water for irrigation. Rather, we are proposing lower water levels that would be commensurate with farming in the area without fear of flooding that would adversely impact planting, growing or harvesting.

With generally higher water levels to the north of G-211 (relocated), higher water levels to the west, and with the institution of a rainfall based delivery schedule to the lower ENP, it may also be determined that the S-331 pump station would hardly ever need to be operated at its design capacity. Most SDCS deliveries will likely be possible by gravity via S-173 and/or siphoning at S-331.

Water Quality Function

We believe that South Dade Agriculture is not adversely impacting water quality in the C-111 Basin as has been claimed by others. However, by reducing or eliminating the need for inputs of water to the ENP from the L-31N and L-31W canals, water quality would be a much lesser question with respect to the Taylor Slough Basin. It should also be emphasized that there is much less likelihood that a gradient would occur for significant periods from the canal system westward to the upper Taylor Slough Basin.

Delivery of high quality water to the southeast ENP will be accomplished through use of the area south of the proposed C-111N canal. Non flood discharges from S-197 should be made in a manner commensurate with the maintenance of estuarine conditions in Barnes Sound and Manatee Bay. Through maintenance of base flows through this facility and sheet flow over the southern bank of C-111, storage availability in the above area can be maintained so that a repeat of the 1988 event might be avoided.

It should be noted that historic water quality in the C-111 Basin has been excellent when compared to that produced in the northern Everglades area. We believe that the slight trend toward higher phosphorous levels in the lower C-111 Basin is as much (or more) related to water management activities over the past decade as it is to increased agricultural activity, as alluded to but not flatly stated in the draft GRR. High water levels in Northeast Shark River Slough have significantly increased ground water levels (for extended periods of time) in the 8.5 Square Mile Residential Area. We believe that this activity has potentially resulted in increased nutrient loads from septic tanks to L-31N, upstream of S-331. It is also possible that the reflooding of NESRS is producing nutrient loads through seepage flows into the northern end of L-31N. Flooding of farm lands could also be a factor. If they are not flooded, water quality will improve. All of the above potential pollution sources will be reduced or eliminated through implementation of the curtain wall in concert with lower water levels east of the facility.

Benefits to Florida Bay

Although we feel that the jury is still out with respect to the actual causes of and solutions to Florida Bay problems, the reduction of eastward groundwater outflows from the Taylor Slough basin and the coincident ability to maintain higher water levels (better than all other alternatives) will increase the southerly groundwater gradients toward the bay. This water will be more available and of a better quality than that which would occur under all other alternatives.

A plan that can be supported by all of the affected parties is more likely to be constructed in a timely fashion. Execution of Alternative 6A, will be delayed if the government has to obtain farm lands by condemnation and then construct all of the physical works that will occupy those lands. Execution of the curtain wall can be "fast tracked" because it will receive a great deal of support from adjacent agricultural land owners and because there is mutual benefit from speedy implementation. Having made the decision to construct this facility, attention can then become more focused on determination of what the actual problems are with the bay and what appropriate actions are necessary to optimize its bio-diversity.

Flood Control Function

As we have indicated on numerous occasions in the past, holding antecedent water table levels high under agricultural areas will result in a demand for higher discharges from smaller, more frequent, rainfall events. This happens because there is no below grade storage available and even small rainfalls can create flooding conditions in root zones. These frequent and higher discharges have been a point of contention between the farmers and those who wish to eliminate farming from the area. For some reason, people have been given the impression that holding lower antecedent water levels results in the release of larger water volumes over long periods of time. **This conclusion is scientifically incorrect.**

With lower water levels east of the curtain wall, more buffer storage will be available in the aquifer for the smaller storm events. This will reduce the pressure to discharge because the agricultural and residential areas will not be held on the brink of destruction, as will be the case with all other alternatives. Runoff volumes from normal rainfall events can therefore be discharged at a slower rate.

Operational Flexibility

Operational flexibility can be easily maintained with the curtain wall through installation of periodic gated culverts (probably at the proposed pumping station locations) to bleed water out of the ENP if desired.

Reversibility

This project is reversible because the curtain wall material can be fabricated in a manner that allow for partial or total extraction. However, it is unlikely that extraction would be required either for water supply or for environmental reasons.

Construction Costs

Ghioto & Associates has been in contact with manufacturers of these materials who have provided examples of similar installations. For a project of this size, fabrication would probably be done on site. They have contacted a Florida contractor who has equipment to construct the trench more efficiently than the methods proposed by the USACE. The equipment has the ability to cut through solid rock with a rectangular footprint. This eliminates the need to split out rock between circular drilled holes as proposed by the Corps. The contractor's installation estimates for the curtain wall range from $3.0 Million per mile for a 40-foot cut to $4.2 Million per mile for a 60-foot cut. Based on modeling done by the SFWMD, we feel that it is likely that the trench will not have to be anchored well into the Tamiami Formation, as assumed by the Corps. Therefore, the actual trench depth should fall somewhere between 40 feet and 60 feet. Assuming an average of 50 feet for depth, a linear interpolation of cost leads to $3.6 Million per mile.

Using the above unit cost, the total curtain wall cost over 16.3 miles would be $58.7 Million. The Corps removed this alternative from consideration because its estimated cost of $108 Million was too far in excess of its estimated land cost for Alternative 6A of $58.9 Million, a figure which we feel is unrealistically low. The above estimates therefore place Alternative 6A and Alternative 9 at roughly the same cost in terms of capital expenditures. And, given that the Alternative 6A land cost is unrealistically low, Alternative 9 becomes the only economically feasible alternative. In addition, it is anticipated that the estimated costs for land acquisition will rise significantly from those included in the document. Conversely, the unit costs for curtain wall construction will likely decrease as a result of competitive bidding for contracts and as experience is gained in its construction.

In addition to the above, construction of this facility would greatly reduce capital costs of other facilities and lands under the C-111 GRR, as well as, the 1992 GDM. This would result from the ability to downsize or eliminate major pumping stations. Operational costs of using S-331 would decrease significantly because it would not be needed except in times of major droughts.

It must be emphasized that the curtain wall eliminates the need to purchase land. Therefore, it will result in annual economic contributions to the local economy over the 50-year life of the project. These annual contributions far outweigh even large differences in the capital costs that are presented in the Draft C-111 GRR. It must also be emphasized that the State of Florida is a partner in this project and should be sensitive economic impacts on the state and local levels. Florida did not enter into the C&SFFCP in order to benefit someone in another state or perhaps outside of the United States.

Section 122 Effects

"Effects of the alternatives on air, noise and water pollution, natural resources, and other types of resources listed in Section 122 of the 1970 River and Harbors and Flood Control Act..."

Table 5-2 qualitatively lists these effects for all of the alternatives. These are interpreted on the following page, using the table legend provided, for historic conditions, existing conditions, Alternative 6A (the Corps' Recommended Plan) and Alternative 9 (Curtain Wall Concept).

This table, as compiled by the USACE, clearly indicates that Alternative 9 (Curtain Wall) is far superior to Alternative 6A (Recommended Plan). While the Recommended Plan **Very Adversely Affects** Man-made resources, employment and displacement of people, the Curtain Wall Concept **has no adverse effects** upon these categories. While the Recommended Plan **adversely displaces (removes) farms,** the Curtain Wall Concept **has no adverse effects.**

In addition to the above, it can be seen that there are a number of ratings in the table with which we take exception. For example, the table indicates that a Beneficial Change will occur to Natural Resources with both plans. Under the criteria used to model the alternatives (all except the Curtain Wall which was not modeled), there is only a small positive effect on natural resources. This is evident from the environmental evaluations provided in the Draft C-111 GRR. However, these could be increased if more water is injected into the C-111 Basin at S-331 (putting the farmers at even greater risk than indicated in the GRR). The Curtain Wall Concept will result in higher and more natural hydroperiods in the ENP without hurting agriculture. **Therefore, is should be concluded that the Recommended Plan has much less benefit to Natural Resources than does the Curtain Wall.**

IMPORTANT PARTS OF TABLE 5-2

CATEGORY OF EFFECTS	HISTORIC CONDITION	EXISTING CONDITION	ALT 9	ALT 6A
Air Pollution	Low	Low	No Change	No Change
Noise Pollution	Low	Low-Medium	No Change	No Change
Water Pollution	Low	Medium-	Beneficial Change	Beneficial Change
Man-made Resources	Low	Medium	No Change	**Very Adverse Change**
Natural Resources	High	Medium	Beneficial Change	**Beneficial Change** **
Aesthetic Resources	High	Medium	Beneficial Change	Beneficial Change
Community Cohesion	Low	Medium	No Change	**No Change** **
Public Facilities and Services	Low	Medium	No Change	**No Change** **
Employment	Low	Medium	No Change	**Very Adverse Change**
Tax Values	Low	Medium	No Change	**Beneficial Change** **
Property Values	Low	Medium	No Change	**Beneficial Change** **
Displacement of People	NA	NA	No Change	**Very Adverse Change** **
Displacement of Businesses	NA	NA	No Change	**No Change****
Displacement of Farms	NA	NA	No Change	**Adverse Change****
Desirable Community Growth	NA	NA	No Change	**No Change****
Desirable Regional Growth	NA	NA	No Change	**No Change****

** We take exception to this rating. See text.

The table states that there will be a beneficial change to tax values and property values under the Recommended Plan and no change with the Curtain Wall. In fact, as will be discussed elsewhere in this response, the change will be very adverse for the Recommended Plan because of the way that the Base Condition was developed. If one can make the base condition perform poorly, then it is possible to show some benefit. However, the Base Condition is not a reflection of Existing Conditions in South Dade. It is not even a reflection of Historic Conditions in South Dade. It is a reflection of how difficult the Corps can make farming in South Dade under its most stringent interpretation of its operational discretion and under the inclusion of all previously implemented policies and structural modifications that may have already adversely impacted agriculture.

The table also states that there would be no change to tax values and property values under the Curtain Wall Concept. We disagree with these findings because implementation of this plan will result in meaningful flood protection for the region and a much higher certainty that "protected lands" will actually be protected.

In addition to the above, we take exception to the No Change entries under the Recommended Plan for Public Facilities and Services, Displacement of Businesses, Desirable Community Growth and Desirable Regional Growth. One should make a close comparison of the effects of the Dairy Rule and Dairy Buyout Program on all of these areas. Removal of farm lands and the increase of flood risk that will be brought about by the Recommended Plan will undoubtedly have similar effects on the South Dade County.

Based on the foregoing, we feel strongly that the Curtain Wall Concept gets a far superior rating than the Recommended Plan under Section 122.

Alternative Plan Evaluation Matrix (Table 5-9, Pg. 5-65)

This table provides a basis for determination of whether or not a given alternative meets the operational flexibility, environmental effectiveness, cost effectiveness and flood control goals of the project. The table provided below provides the USACE evaluations of Alternative 6A (the Selected Plan) and Alternative 9 (Curtain Wall Concept). In addition, we have included our own evaluation of these factors. The differences between the two are discussed in the following.

IMPORTANT PARTS OF TABLE 5-9

Evaluation Factors		
OPERATIONAL FLEXIBILITY	**ALT 6A**	**ALT 9**
a. Maintain natural water levels along boundary of headwaters and upper Taylor Slough	Y	N
b. Control location of flows into:		
- Taylor Slough headwaters/upper	Y	Y
- Taylor Slough middle portion	Y	Y
c. Control timing of flows into:		
- Taylor Slough headwaters/upper	Y	N
- Taylor Slough middle portion	Y	N
d. Control flows to east-west spreader canal lands	Y	Y
e. Minimize flows to Manatee Bay/Barnes Sound	Y	Y
f. Uniform sheet flow to lower Taylor Slough	Y	Y
g. Increase hydroperiods in headwaters and upper Taylor Slough	Y	Y
h. Increase average depths in headwaters and upper Taylor Slough	Y	Y
ENVIRONMENTAL BENEFITS		
a. Increase hydrohabitat units	332	NA
b. Increase species compatibility indices	NA	NA
COST EFFECTIVENESS		
Total Annual Cost ($ Million)	11.9	14.0
FLOOD CONTROL IMPACTS		
Annual flood damage reduction ($ Million)	3.4	NC

Operational Flexibility is first defined in terms of holding higher stages around only the perimeter of northern Taylor Slough. With the Curtain Wall Concept, this criterion for success is Not Applicable, because higher perimeter stages are not needed to make the plan function properly.

All other measures of flexibility relate solely to the provision of properly timed external flows to the Slough. These criteria are also Not Applicable because the real purpose of the project is to maintain higher stages in the Northern Taylor Slough Area. The timing of stages (as well as magnitude) will be far superior to Alt. 6A because it will be more natural than we could make it through artificial pumping.

The last flexibility criterion, increasing average depths in the headwaters and Upper Taylor Slough, will be far better with the Curtain Wall, because higher depths can be accomplished with less water than with the Recommended Plan.

Environmental Benefits will also be greater with the Curtain Wall. It does not take modeling, although we would like to see it, to conclude that hydrohabitat units will probably be an order of magnitude higher than the very weak showing provided by the Recommended Plan.

Cost Effectiveness is about the same as discussed previously. The numbers in the table should therefore be revised.

Flood Control Impacts are placed at $3.4 Million/year for the Recommended Plan and were not computed for the Curtain Wall Concept. We feel that a properly executed flood damage assessment along with proper hydrologic analyses will produce flood control benefits for the Curtain Wall that will far out strip those indicated for the Recommended Plan.

Again, it is obvious to us that the Curtain Wall Concept is by far the better of the two plans in all respects.

Concluding Remarks

South Dade agriculture is willing to work with the Corps, the District and the Park to further develop this conceptual plan through analysis of hydraulic performance and the development of design strategies. We are flexible with respect to design details, construction materials and construction methodology. We are also willing to support a demonstration project on the concept to determine actual effectiveness as well as to develop optimized designs and construction methodologies. It is our sincere belief that this type of plan is the answer to perceived coexistence problems between agriculture and the environment. It is also much more responsible in terms of public expenditures and economic benefit to the region than are all other proposed alternatives.

PART B
OTHER QUESTIONS AND COMMENTS

The following contains our comments on the subject draft GRR and a number of questions regarding technical aspects of the Recommended Plan and associated analyses. I request that the questions posed in this letter be individually reproduced and answered in writing within the next edition of the GRR document.

1.6.7 Hole in the Donut Restoration

We find it interesting that the park wants to build the east side of the Frog Pond up by 2 to 3 feet and then purchase it for buffer. Why not continue to farm it?

2.2.4 Modified Water Deliveries GDM

The Everglades Protection and Expansion Act also provided for flood protection for the 8.5 square mile residential area and adjacent agricultural areas.

2.3 WATER QUALITY

"The recent die-off of vast areas of seagrass in Florida Bay and the persistence there of a very damaging algae bloom is considered by some to be a result of nutrient pollution."

"Some" also believe that some nutrient pollution is coming from septic tanks and urban runoff in the Keys. "Some" also believe that nutrients are being imported from the west via littoral currents bringing Shark River Slough waters into the Bay. "Some" also believe that the algae blooms are related to temperature in the Gulf of Mexico. This litany can go on. The point, however, is that we still do not know what the problems are.

What is the Corps' definition of "some"? These kinds of statements should be qualified so that they do not, by inference, place blame where it should not be placed.

"Phosphorous levels at S-332, S-175 and S-18C are low but have been increasing in recent years, and now frequently exceed target levels. This is

believed to be a result of increasing agricultural use and changes in land use in the Taylor Slough Watershed."

Who "believes" this is true, the Corps? Is this statement an act of faith or a statement of fact? Where are the data that support this "belief"?

Do the S-12 structures and the L-28 Borrow Canal currently meet target levels? If not, then could some of these nutrients be reaching L-31N through seepage?

Ghioto & Associates has analyzed Total Phosphorous data provided by SFWMD for the period between 10/5/1983 and 5/25/1993 at S-176, S-177 and S-332. These data were screened so that only information available at all three sites on the same days was considered. In general, where higher levels persist for more than one sampling, Total P at S-176 exceeds values at S-332 and S-177. This indicates that the Frog Pond is not a significant day to day contributor of phosphorous to the system.

Any statement about the source(s) of elevated phosphorous levels is sheer speculation at this time because there is no long term monitoring station between Tamiami Trail and S-176. Samplings taken by Hydrologic Associates on behalf of South Dade Land Corporation indicate that these contributions could be entering the C-111 basin via S-331. The "belief" that higher levels are due to local contributions is pure supposition and does not belong in a document produced by a public agency.

If water quality is to become an issue in South Dade, it is recommended that additional sampling stations be established at Tamiami Trail, G-211 and S-331 so that people can deal with data rather than speculation.

3.7 WATER QUALITY

"Agricultural and urban areas in the northern Everglades are expected to continue to influence water quality in the study area and Everglades National Park if no further action is taken."

Is this paragraph addressing areas north or south of Tamiami Trail? If the answer is north, then this statement only has meaning in terms of water imported into South Dade County by the Corps' project, the South Dade Conveyance System and the NESRS restoration.

The discussion on Mercury levels is totally irrelevant to this project.

2.4 ENVIRONMENTAL RESOURCES

This section indicates that Shark Slough spills over to Taylor Slough at Elevation 6.5 feet (measured at P-33).

Is this conclusion drawn from surveyed topographic data?

Is it appropriately included in the model(s), or averaged over two miles?

Was this potentially adverse impact to private lands to the east considered or even mentioned in the Modified Water Deliveries to Everglades National Park, June 1992?

Did the Corps incorporate the Grossman Road Borrow Canal into the model(s) and evaluate its impacts as indicated on page F-62 of Modified Water Deliveries to Everglades National Park, June 1992?

What effect do all of the above considerations have on the Base Condition used to evaluate alternatives and assess damages? Please provide a numerical analysis of these effects.

2.9.8 Storms of June 1988

"The question arises why flooding occurred when design stages were not exceeded. First, the design stages in L-31N are close to the natural ground elevation and secondly, there is an almost complete lack of a secondary drainage system in the area."

How can one expect secondary drainage systems to perform if canal stages are kept at ground level during a flood? The design stages for the canals should be lowered so that drainage from uplands can occur.

2.9.9 Storms of August 1988

S-331 was used to accumulate storage of waters in the lower C-111 Basin which were pumped into the Basin via S-331. This water was pumped to offset the negative impacts of flooding NESRS on the East Everglades. The Water Deliveries Testing Program is responsible for this problem. The problems in Manatee Bay/Barnes Sound would have been much less catastrophic if this accumulation had not occurred. Termination of S-333 discharges had little effect because use of S-331 is related to rainfall over the Slough that adds elevation on top of the higher water levels induced by use of S-333 over long periods of time.

3.3.2 Flood Control

"Unless lands are taken out of production for future environmental acquisitions, the flood damage susceptibility will remain the same."

We take exception to this conclusion at this location in the report because that it is factually incorrect. There are alternatives that will provide flood protection to all of the agricultural lands and that will accomplish environmental (hydroperiod) goals of the ENP without taking lands out of production.

3.8 ENVIRONMENTAL RESOURCES

(Note: Page 3.6 was not in our copy of the document. Therefore, the following comment is from the previous draft.)

"In 1969-1970, coincidentally with a drop in water level in the northern part of Taylor Slough, abrupt changes in timing of nest initiation occurred in wood stork colonies; the change adversely affected nesting success. From 1981 to 1993, Cape Sable sparrow nesting attempts declined by 75 percent; sparrow habitat had been invaded by woody vegetation. Roseate spoonbill colonies have diminished since the early 1980s."

Are you sure that the decline in sparrow nesting and the diminishing of Roseate Spoonbills in recent years is a not a result of too much water in their habitat? For all of the species listed above, the collected data should be presented and references of sources of the data cited.

"Reversal of this trend of desiccation is regarded as a Federal responsibility."

There is also a Federal responsibility to the homeowners, workers and businesses of the region which comprise the "human environment" under NEPA.

SECTION 5 FORMULATION OF ALTERNATIVE PLANS

Most of our discussion of this subject is contained in Part A where we compare the Curtain Wall Concept to the Recommended Plan. Therefore, our comments here are of a general nature.

This section describes the methodology for evaluation of the various alternatives. Because the Corps removed the Curtain Wall from consideration as a result of disputable cost data, it was not included in the environmental analyses and comparisons. We feel that the Curtain Wall should be objectively analyzed (through modeling) with appropriate consideration given to design optimization. If this is done, it is our opinion that this alternative will provide superior environmental enhancements over the Recommended Plan. We hereby request that this be done.

5.1 FEDERAL OBJECTIVE

It appears that the federal objective for this project has been changed from one of economic development to one of environmental restoration without economic considerations related to improving the NED (National Economic Development), the OSE (Other Social Effects) or the RED (Regional Economic Development) accounts. In fact, the report assumes that, if flood damage prevention remains the same as in the original project, then there are no negative effects on the economic and social accounts. In our opinion, this assumption is wrong and the Corps should include negative impacts on the NED, OSE, and (in particular) RED accounts in its Environmental Impact Statement under NEPA. The reason why this assumption is wrong, is that over 5,000 acres of extremely productive farm lands (the Frog Pond), which were originally envisioned to have flood protection under all previous plans, are being removed from the NED and the RED accounts by the preferred plan. In addition, the OSE is being negatively affected as a result of impacts to people in terms of employment and general economic dislocation.

In addition to the above, it is our opinion that economic and environmental objectives are not mutually exclusive if the Corps, the ENP and the SFWMD are willing to consider potentially less costly alternatives to the preferred plan.

"Because of the environmental nature of this reevaluation report, the determination of an NED plan which is normally required for a flood damage prevention project, will not be accomplished within this report."

The environmental nature of the report is not grounds for ignoring the NED aspects of the plan. In fact, there should be an effort on the part of the Federal and State governments to attempt to improve the economic and human environments as well as the natural environment. Instead, the Recommended Plan attempts to remove the idea of flood protection for the area through erroneous technical assumptions and inappropriate modeling.

6.3 PLANNING CONSTRAINTS

It is our opinion that scope and time requirements for study completion should not be a study constraint if it leads to a plan which negatively impacts the region and does not produce the desired degree of hydroperiod changes thought to be necessary by ENP staff. The "do something now" attitude that has been driving the restoration process for the past decade has resulted in the degradation of Barnes Sound in 1988 and has potentially negatively impacted Florida Bay and Taylor Slough by the instantaneous shifting of huge volumes of water from one location to another.

<u>Experimentation with hydroperiods in the Everglades can be accomplished by less costly methods; can be unconstrained with respect to water elevations; and, can begin much more quickly if our proposed alternative were to be implemented.</u>

We feel that the separation of operations from structural elements is a mistake because it limits the economic viability of the final plan. It also introduces a high degree of uncertainty into the process on the part of affected parties. While it is agreed that the plan should provide a range of variability in water levels within the ENP for biological ehancement, we feel that a range of operations to the east, including lowered optimum levels, would provide for more agricultural certainty. The farmers of the region are sincerely concerned that a plan will be formulated which will, in the end, be operated to their detriment on the grounds that "environmental optimization" is necessary. Again, these two goals are <u>not</u> mutually exclusive. In addition, lowered water levels to the east are not necessarily inconsistent with water supply needs associated with well fields, salinity intrusion control, or the estuarine needs of the east coast.

5.5 EVALUATION FACTORS

This list of evaluation factors should have included negative effects on the NED, OSE and RED accounts as previously indicated. These should be conducted after a realistic approach to determination of flood damages has been executed.

5.6.1 Background

"However, these studies would have extended the study duration by more than 1 year."

As stated previously, the study time line is not a valid excuse for ignoring important data and information deficiencies. This project should go through one more iteration, which includes an appropriate evaluation of the Curtain Wall Alternative before a Recommended Plan is proposed.

5.6.4 Final Alternatives

We feel that the use of an uncalibrated, unverified 1x1 version of the SFWMM is totally inappropriate for evaluation of flood prevention performance as well as flood damage assessment. This will be discussed in more detail later in this response.

Table 5-2 Effects Evaluation, Section 122

Please provide the rationale and numbers supporting the "no change" ratings given to Displacement of People, Displacement of Businesses, Displacement of Farms, Desirable Community Growth, and Desirable Regional Growth. The table shows that there will be "very negative" effects on Man Made Resources, Employment, Tax Values and Property Values. <u>Why are these not quantified in physical and economic terms and discussed in detail as "human environment" impacts?</u>

Table 5-12 Preliminary Analysis of Annual Benefits and Costs

An additional row should be added to this table to show Benefit to Cost Ratios of all of the alternatives.

	B/C Ratio
ALT 1	0.80
ALT 1A	1.03
ALT 2	0.87
ALT 3	0.52
ALT 4	0.32
ALT 5	0.70
ALT 6	0.34

These numbers indicate that the public is expected to be willing to receive a return of 34 cents on the dollar to achieve the minor environmental benefits offered by the preferred plan (ALT 6, ALT 6A). Would it not be wise to attempt to achieve higher environmental benefits <u>and a higher return on investment</u>?

ENVIRONMENTAL EFFECTS OF SELECTED PLAN
6.1 PHYSICAL FORM

This paragraph, extolling the bounteous results of this project, is totally inconsistent with the rest of this section which indicates that the environmental benefits are minimal. This is discussed more fully below.

6.2 HYDROLOGY

"The impact of having an extended area of pumped discharges in Plan 6A causes higher groundwater levels along the eastern border of the Park with resultant loss of hydraulic slope away from Shark River Slough and an increase in total volume remaining in the slough."

Is there enough pumping capacity proposed to completely handle all of the seepage that will cross under the levee? Do we run the risk of having to continuously discharge from the C-111 system to make up differences? If so, has the Corps considered the environmental consequences of a continuous discharge from the system?

The above statement, as well as all others related to the "environmental benefits" of the selected plan, is derived from the hydraulic provision of a head along the eastern side of the park so that water losses are reduced and hydroperiods extended. <u>This goal can be attained without acquisition of the "buffer area". As a matter of fact it can be attained while lowering operating ranges to the east. The fact that this can be accomplished with physical facilities leads to a question of why must the lands be purchased at all?</u> Aesthetics?

In addition to the above, it would seem logical that a more passive method could possibly be employed to retard easterly water losses from ENP without the requirement of land and with much less pumping capacity than 1200 cfs.

"Soil moisture storage in the initial 1.5 feet of unsaturated ground above the water table provides about 3.6 inches of rainfall storage."

This statement assumes that there is no antecedent rainfall prior to the storm event (based on a storativity of 0.2 ft/ft). Recent experience in the eastern portion of the Frog Pond indicates that once the water table rises above the level of native rock, capillary action becomes important. The soils in this area have a high marl content and have been vertically well mixed from the surface to the top of native rock. How does this behavior and antecedent rainfalls prior to the storm event affect the proposed plan's performance?

"The remaining volume of the 10-year, 5-day storm is removed by project structures."

This statement implies that the water stored in the upper 1.5 feet will remain there for the duration of the storm, which would kill most vegetable crops. Was this factored into the flood damage computations? If this volume (3.6 inches) is considered to be buffer, then it should only be counted when it occurs at depths of 1.5 to 3.0 feet.

6.3 ENVIRONMENTAL RESOURCES

In this paragraph and in paragraph 6.4, the environmental report card on the selected plan is presented. Excerpts are as follows:

Cape Sable Sparrow (No Difference) - **"These criteria are met fairly well under the existing condition, and none of the evaluated alternatives would change this very much........None of the considered alternative actions would adversely affect the sparrow."**

Snail Kite (No Difference) - **"..... the snail kite will be essentially unaffected by the considered project"**

Wood Stork (Marginal Benefit) - **"Although the habitat improvement is marginal, the considered alternatives will not adversely affect the wood stork"**

Bald Eagle (No Difference) - **"There would be no effect on bald eagles from implementation of any of the alternatives."**

Indigo Snake (No Difference) - **"No effect will occur to the eastern indigo snake.."**

Florida Panther (No Difference) - **"Considered alternative actions would not adversely modify habitat for panthers, and the considered project would have no effect."**

American Crocodile - **"....we have determined that the alternative actions would not adversely affect the American crocodile."**

We have two concerns with this section and the selected plan's performance. The first is related to the justification for spending <u>121.7 Million Dollars</u> of taxpayer's money for this result.

The second concern is the indication that the proposed hardware may give better results under "a different water control schedule". What type of schedule is meant here? Is the Corps suggesting that facilities and operation can not be separated as stated earlier in the report? Does this mean that S-331 will be used to divert water from the north into the C-111 Basin via S-331?

6.6 WATER QUALITY

"As discussed in section 2.3, nutrient enrichment resulting primarily from agricultural runoff is the major water quality problem in the Everglades. Although nutrient levels are low in the Taylor Slough drainage [basin,] they frequently exceed targets established for the input points at S-332, S-175 and S-18C. The water delivery systems discussed in this report are not specifically designed to address nutrients; however those that incorporate retention areas or flow-ways will have a beneficial water quality impact."

This section attempts to lump South Dade agriculture into a broader group having much different farming methods, crops, soils and water management techniques. The target exceedences discussed may not be the result of South Dade agriculture at all (see our pervious discussion).

The use of retention areas or flow-ways in South Dade would be much harder to achieve than in the northern Everglades because of the extremely high permeabilities and transmissivities encountered within the Biscayne Aquifer area.

6.8 AGRICULTURE

The conclusions presented here are predicated upon the operational strategies assumed in the modeling. If modifications to operations are necessary to achieve desired environmental benefits, then there is a genuine concern to agriculture as to how the system will perform under flood conditions. "Optimization" of environmental benefits could easily be translated to increased flood risk for the protected region as has happened over the past several years.

Flooding concerns to agriculture are related to the smaller storm events as much as to the larger. There has been a tendency to reduce discharges from the system (operationally) and at the same time maximize water table levels. This leads to loss of natural buffer storage and increased demands to operate the system in a flood control mode.

If water levels west of the proposed levee are increased, what effect do they have on required pump station design capacities?

"The effect of land purchases is to remove cropland from production and therefore reduce damage susceptibility in the study area."

This concept fails to consider the negative permanent loss of agricultural lands in the area. In addition, it should not be used to imply that purchase of agricultural lands in this manner is necessarily the most cost effective means of achieving flood control.

In addition, to the "profit" loss indicated in the report, there will be a ripple effect throughout the entire local economy. Profit by the producer is not the only benefit of having farming in the area.

6.10 DISPLACEMENT OF PEOPLE, BUSINESSES AND FARMS

What are the numerical economic effects in terms of loss of jobs and loss of business with the removal of agricultural lands from the area?

6.18.1 MODIFIED WATER DELIVERIES TO ENP

"During non-flood conditions, excess seepage water from Shark River Slough collected in L-31N borrow canal could be passed to the C-111 system for enhanced hydrologic restoration of Taylor Slough."

This statement is in direct conflict with the statement made in Section 8.5.1.t regarding S-331 Operation. If S-331 is not going to be used for this purpose, then how will it be accomplished? Will you wait till water levels drop and then pump them up for some undetermined period of time?

South Dade agriculture has been concerned about pumping seepage waters at S-331 for nearly a decade. The huge volumes of water sent to the south have been responsible for the environmental damage to Barnes Sound in 1988 and may now be partially responsible for conditions in Florida Bay. When G-211 was constructed, we were told that it would reduce the need to discharge seepage waters to the south. Although the annual flows have decreased, the Corps and the SFWMD are using seepage from this system to artificially extend wet season hydroperiods on agricultural lands to the south of S-331. The farmers are opposed to this becoming a design feature of the plan.

On page F-60 of the 1992 GDM, the Corps responded to our questions regarding modeled seepage to L-31N from NESRS and our concern, under flood conditions, that the anticipated pressure that increased seepage would place on downstream systems. Excerpts from the Corps' response are provided below.

"In calculating seepage into L-31(N) south of Tamiami Trail, it is assumed that the layer of silt and organic marl overlying the highly permeable limestone retards seepage into the canal during flood stages....... During the FDM design phase, the continuity and permeability of the organic upper layer will be investigated. The investigation will include percolation tests, pump tests, and a possible canal drawdown test."

Have these tests been done and a conclusion reached? If seepage rates to the L-31N canal increase dramatically, what will the Corps do about it? If seepage rates are higher, how will this affect forward pumping at S-331 to the south? Will there be rules of operation that prohibit moving this water to the south?

APPENDIX A HYDROLOGY AND HYDRAULIC ANALYSIS

Use of the 1x1 Model

We take exception to the technical adequacy of the 1x1 model for determination of flood stages, and therefore flood damage assessments, in the agricultural areas. This model is probably adequate for determination of relative environmental merits of plans within the ENP. However, it is inadequate for flood assessments because it does not have the required absolute accuracy. Model characteristics that must be considered are as follows.

Average land elevations over a 1x1 square mile area are not adequate to determine the point at which crop damage or surface flooding begins. This is especially true when one considers the level of accuracy possible in the developed areas.

In addition to the averaging over space, the 1x1 model uses daily values of rainfall to compute stages and discharges. It also produces average daily stage as an output. How can you use average daily peak stage to predict whether there will be damage to crops with a 12 hour susceptibility.

Modeling of Channels

In older versions of the model, a single channel reach was used between structures, regardless of the number of grids that it intercepted. Is this the case for the 1x1 Model also?

If the answer to the above question is yes, then how can one expect to obtain an accurate estimation of stage gradients between the structures? How can one have confidence in evaluation of the effects of a canal with a flat pool (numerically) on seepage from surrounding grids with varying water table elevations?

If the 1x1 model does have the capability to model channel reaches at a grid resolution, then how can we rely on calibrations from an inherently different model?

Physical Model Input Data

How were average land elevations assigned to grids east of L-31N and C-111?

What was the density of known land elevation points per square mile?

What is the computed confidence interval for average land elevations assigned in feet? Does this input data limitation vary spatially throughout the area and, if so, by how much?

Because the model uses average land elevations, one can expect that half of the land is below the stated average and half is above the average. What is the deviation on a grid by grid basis east of the L-31N and C-111 canals?

Boundary Conditions

What boundary conditions were used along the eastern and southern perimeter of the model grid?

What would be the effects of hurricane and tropical storm surge on computed elevations in the C-111 Basin? Was a sensitivity analysis to boundary condition water elevations conducted for storm event runs? If not, why not?

Calibration and Verification

Please provide the calibration and verification run results for the 1x1 model as used in this GRR.

Seasonal Flood Occurrence

The report states that the "2-year 5-day rainfall total of 7.2 inches was used to represent the beginning of flood damages". However, it does not provide the justification for making this selection. This is important because this assumption leads to the elimination of all potential damages to row crops between November 1 and March 31 of all years. Based on our experience in the area, we feel that damaging rainfalls of lesser volume are probable.

Please provide your justification for this very important assumption.

Please provide an updated analysis of % Chance based on up to date rainfall records. Why was the analysis stopped at 1977? There are at least another 15 years of record that could be used. I know of problem years since that date.

Optimum Water Levels

Table A-5 provides the structure operation levels used in the model. Why are these numbers different (higher) from project optimums at S-176 and S-174? Is the Corps refining the optimum water levels or just boosting them to be conservative? Or are they higher to account for some average stage condition between the structures? The answers to these questions are very important.

Base Condition Used

The Base Condition is used to establish a benchmark for determination of benefits and impacts that would result from alteration of the system from that condition. The base condition consists of a set of assumptions regarding existing structures, their configuration and their operations. The degree to which a project affects the environment (including the human environment) can be altered through alteration of the assumed base condition. For example, if the base condition can be made to look very bad, then almost anything will appear to be an improvement. The C-111 Draft GRR does an incredible but elegant job of manipulating the base condition, and thus the outcome of the alternatives evaluations.

a. Inclusion of the 1992 Water Deliveries GDM

Indirect impacts on the agricultural areas west of L-31N are effectively ignored with inclusion of this design into the base condition.

b. Inclusion of the C-111 Interim Plan
We have repeatedly asked the Corps to evaluate the Interim Plan for C-111 with respect to adverse impacts on South Dade agriculture. Since 1989, our requests have been ignored. At this time, this unevaluated plan is being included into the Base Condition and its impacts are being ignored here also. Why?

In our opinion, the lands east of C-111 have never seen the Base Condition as defined in the GRR.

Flood Profiles

The flood profiles contained in Plates A-10, A-11 and A-12 are from the Supplement 37, September 12, 1963. Please update these to show how plan performance has affected them. Perhaps peak canal discharges could be used along with HEC-II for this purpose. This effort should not take more than a few days of labor and would shed a great deal of light on our ability to evaluate this plan. We do not feel that stage results directly from the 1x1 model are appropriate for this purpose. We assume that you feel the same way since a similar analysis was used to test tailwater effects on structures discharging to the ENP.

APPENDIX E SOCIAL AND ECONOMIC ANALYSIS

We feel that the flood damage assessments presented in this appendix are flawed as a result of hydrologic assumptions made, the model used and the quality of topographic data in relation to sensitivity of crops to high water conditions.

The hydrologic assumptions with respect to initiation of flood damages totally remove any damages that might occur between November 1 and March 31 of each growing season for row crops.

The model, as discussed previously, is inappropriate mostly because of the spatial averaging over a square mile and the temporal averaging of peak stages for crops with less than one day of susceptibility.

In addition to the above, it is assumed that all row crops will have roots extending only 0.17 foot below natural ground and that water levels must reach that level before damage can begin. Vegetable crops are planted in rock plowed areas where the overlying marl soils are mixed with rock to a much greater depth than 0.17 foot. As a result, when water levels are within the rock plowed depth, the soils absorb water upward (via capillarity) and become saturated.

When the water table stays in this zone for an extended period of time (even below the roots by measurement in a well), the soil column will stay saturated to the top of the bed. Therefore, crops will become susceptible to flood damage with lower water levels than indicated in this appendix. In addition, it will take much longer to drain the soils and crops will be damaged worse than anticipated.

We feel that these factors are not properly handled in the analyses and that there will be far greater agricultural damages (east of the canals) than are indicated by the GRR. We also feel that the design parameters in the GRR as well as anticipated operational strategies will contribute to these damages.

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April 8, 1994

Mr. Stephen Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-1104
Attn: CESAJ-PD-PF

Re: Public Meeting on a Study for Structural and Non-structural Modifications to The C-111 Basin, South Dade County, Florida

Dear Mr. Sutterfield:

The plan proposed for purchase of private lands west of C-111 known as the Frog Pond and Rocky Glades agricultural area is taking of personal property against the will of landowners.

Alternate 9 to install a 60 ft. deep curtain wall is estimated to cost $108 million. It is not known if the curtain wall needs to be 60 feet deep. Assuming a 30 foot depth (and perhaps even a 20 foot depth may be adequate) would be adequate to reduce ground water movement sufficiently to develop a head of water west of the curtain in the Everglades National Park (ENP) the cost of the curtain would be similar to your estimated cost of purchasing the land.

I propose you develop testing to determine the depth required for the curtain to give the necessary head to provide water to the ENP and to the Bay. Then private citizens can maintain their property, growers can continue to farm, the park and bay can have the water they need.

Thanks for this opportunity to reply regarding the study on THE C-111 BASIN in addition to speaking at the public meeting.

Sincerely yours,

Herbert H Bryan

Herbert H. Bryan
Professor & Acting Center Director

MF04C111BA8

SERVE • CONSERVE

MIAMI-DADE WATER AND SEWER DEPARTMENT
4200 Salzedo Street, Coral Gables, Florida 33146 • Tel: 305-669-3700 • Fax: 669-3788

April 18, 1994

Col. Terrence Salt
U.S. Army Corps of Engineers
Jacksonville District
P.O. Box 4970
Jacksonville, FL 32232-0019

Re: Draft Integrated General Reevaluation Report (GRR) and Environmental Impact Statement (C-111)

Dear Colonel Salt:

We have reviewed the subject document and, in concept, find conclusions supportable. Miami-Dade Water and Sewer Department (WASD) has two points to make, that go beyond the general goals of the GRR as follows:

WASD is currently in the process of evaluating treated wastewater re-use alternatives. While the concept of land application to golf courses and other public areas may be the easiest to permit, we believe that returning this resource to Western Dade County may constitute a higher use. WASD would urge that the GRR, and the stance of the USCOE in general, would lend support to the concept of returning treated wastewater to Western Dade County.

Secondly, use of our water resources must be balanced between environmental, agricultural and domestic requirements. We are concerned about the lack of consideration given to domestic users. Major well fields operated by Homestead, Florida City, Florida Keys Aqueduct Authority and WASD may be impacted by the redistribution of water within the C-111. As it appears that the recommended alternative 6A has not been modeled in detail and that strict operating parameters have not been established, the use of existing well fields and planning of future well fields will be very difficult. WASD strongly suggest detailed modeling to be done and strict operating parameters be established to predict the impacts on exisiting and future well fields.

Sincerely,

Tony

Anthony J. Clemente
Director

JC/gy

BARNEY W. RUTZKE, INC.
AGRIBUSINESS

OFFICE: 17855 S.W. 248th Street, Homestead, FL 33031
305/245-4595 FAX# 305/248-5938

SHOP
17855 S.W. 248 St.
Homestead, FL 33031
305/247-1725

RANCH
813/637-8967
813/637-9377

APRIL 18,1994

COL. TERRANCE SALT
U.S. ARMY CORPS OF ENGINEERS
400 W. BAY ST.,ROOM 939
JACKSONVILLE, FLORIDA 32232-0019

RE: C-111 REEVALUATION REPORT (FEB 1994)

DEAR COLONEL T. SALT,

YOU SHOULD BE FAMILIAR WITH THE PHOTOS OF OUR MATURE TROPICAL FRUIT GROVES LOCATED IN THE ROCKY GLADES FARM LANDS, WEST OF L31-N. THESE VARY LANDS HAVE BEEN FARMED SINCE THE 1950'S. SINCE YOU HAVE ALSO MADE IT IMPOSSIBLE FOR US TO CO-EXIST WITH OUR NEIGHBORS, EVERGLADES NATIONAL PARK AND SOUTH FLORIDA WATER MANAGEMENT, SOMETHING MUST BE DONE.

IT IS NOT A QUESTION AS TO WHETHER WE AGREE WITH THE DRAFT OR NOT. THE FACT IS THAT YOU HAVE BEEN VERY SUCCESSFUL IN TAKING OUR LAND, WITH NO REGARDS TO OUR PRIVATE PROPERTY RIGHTS.

THEREFORE, WE THINK THE GOVERNMENT SHOULD BE RESPONSIBLE FOR PURCHASING THE PROPERTY AT A FAIR PRICE. WE ALSO THINK WE ARE ENTITLED TO COMPENSATION FOR THE ECONOMIC IMPACT UPON OUR BUSINESS. FARMING IS OUR ONLY LIVELIHOOD AND WAY OF MAKING A LIVING. WE WILL SUFFER A GREAT LOSS OF INCOME AND SHOULD BE COMPENSATED FOR SAME AND MADE WHOLE.

IT IS URGENT FOR ALL INVOLVED THAT YOU TAKE DECISIVE MEASURES.

SINCERELY YOURS,

Barney W. Rutzke Sharon D. Rutzke

BARNEY W. RUTZKE SR. SHARON D. RUTZKE

Milledge Iden & Held
A PARTNERSHIP INCLUDING PROFESSIONAL ASSOCIATIONS
ATTORNEYS AT LAW

Allan Milledge
Bruce Franklin Iden
Gary M. Held, P.A.
Dana J. McElroy

OF COUNSEL:
Florence Snyder Rivas
John M. Milledge, P.A.

March 30, 1994

Terrence C. Salt
Colonel, U.S. Army
District Engineer
Department of the Army
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Colonel Salt:

Just a note to thank you for the dignity your presence gave to the hearing last night in Homestead. We all appreciate your efforts.

The proposed plan, 6A, is an excellent one which I support. The buffer design will work, I believe, and in various configurations can be extended along most of the east side of the Park and Conservation Areas.

I would also support filling in the C-111, not because I'm worried about it being used for flood control or because I'm worried about Barnes Sound, but I do believe that restoring sheet flow to the area west of US1 is difficult when a canal intercepts the flow.

Thanks again.

Sincerely,

Allan Milledge

Allan Milledge

AM/ip

SUITE 600 • 2100 PONCE DE LEON BOULEVARD • MIAMI, FLORIDA 33134 • TELEPHONE (305) 445-1500 • FAX (305) 446-9972

HYDROLOGIC ASSOCIATES U.S.A., INC.
ENVIRONMENTAL CONSULTANTS

MIAMI
8925 S. W. 148th Street, Suite 212,
Miami, Florida 33176
Phone: (305) 252-7118 • Fax: (305) 254-0874

ORLANDO
109 Bayberry Road
Altamonte Springs, Florida 32714
Phone: (407) 788-1355 • Fax: (407) 788-1135

April 18, 1994

Mr. Ed. Salem
US Army Corps of Engineers
Federal Building
P.O. Box 4970
Jacksonville, Florida 32232-0019

RE: **Canal 111 GRR**
Review Comments - February 1994 Version

Dear Mr. Salem,

The following comments are presented for your review and consideration in preparation of the final GRR for Canal 111. These comments, presented in no particular order, should be considered in addition to my comments addressed to you in January 1994. Most of these comments have been presented at public hearings over the last few weeks.

The restoration goals for the Park can be accomplished by both plans 6A and 9, as stated in the GRR. The primary difference between the two plans is how to handle the increased seepage from additional water in the Park. Plan 6A requires the condemnation of 11,000 plus acres of farmland (about 1/3 of the farmed acreage in the basin); plan 9 requires very little condemnation of land but involves application of existing geotechnical technology to retard seepage from the Park to the developed areas in the east.

The aquifer in south Dade County is highly permeable and literally does not hold water. Since drainage has occurred in south Dade in the 1960's, there is no longer the hydraulic pressure in the east to retard seepage coming from what is now the Everglades National Park. An effective seepage control measure has to be included in the C-111 GRR because there is no longer the hydraulic pressure to prevent flow to the east. The selected plan 6A provides for a series of pumps to supply water to upper Taylor Slough and provide flood protection to the upper C-111 basin. These pumps will be recirculating a considerable amount of seepage water as is now the case with S-332. Because there are no operational criteria in the GRR, it is impossible to analyze the flood protection capabilities of the 6A design. If the pumps do not work effectively in restoring target water levels in the Park the only option is to raise water levels in the Levee 31N borrow canal which would jeopardize the developed areas east of the levee, thus condemning even more land by removing flood protection capacity. Effective seepage control has to be part of the C-111 GRR if restoration and flood protection needs are to be met. Plan 9 provides for a solution to both goals. The curtain wall that is proposed will solve both problems.

The economics of plan 9 will justify its implementation when a more realistic cost is placed on the construction of the curtain wall and the long term maintenance of 11,000 plus acres of abandoned farm land. I urge you to consider different geotechnical methods that are more cost effective and reversible. I could not find in the GRR the long term costs of maintaining abandoned farmlands nor who would be responsible for this cost and allocation of work. Could you please provide me with this.

In the GRR it is stated that the maintenance of water levels through the South Dade Conveyance System (SDCS) is for water supply and retarding saltwater intrusion. There is no evaluation of the saltwater intrusion extent since the SDCS became operable. These data should be available from the US Geological Survey and be presented, if the operation of the C-111 system is to retard saltwater intrusion.

It is stated in the GRR that there may not be enough water in the basin to meet the restoration goals of the Park and that water may need to be imported (probably via S-331). A solution that was not addressed in this GRR is backpumping the adjacent coastal canals: C-102 and C-103. The water in the western reaches of these canals historically provided base flow to Taylor Slough, but is now discharged to tide. Rather than import water through an interbasin transfer at S-331, it would be worth a strong consideration to backpump excess water that historically did go to Taylor Slough. Capturing of excess water in the western C-102 and C-103 would solve both quantity and quality problems in the Taylor Slough/C-111 basins.

In summary there are three areas that need further consideration in the development of the GRR: Seepage control, backpumping local basins, and the economics of implementing the plan. By controlling seepage losses, the restoration of the Park and Florida Bay can proceed in a timely manner and the eastern areas of the basin can be provided adequate flood protection. This is a definite win-win situation. Backpumping of local runoff can provide an ample source of high quality water that was historically part of the Taylor Slough Basin. This would eliminate the need for an interbasin transfer transfer of water and reduce the loss of a valuable water resource to tide. These basins are now out of the scope of the C-111 GRR but should be brought into the plan to incorporate a much needed change in the water management in South Dade. Finally, the economics of a curtain wall must be re-evaluated based on existing technologies. Once this re-evaluation is made you will find it to be a more cost effective alternative for the restoration of the Park and the protection of the eastern, developed areas as opposed to condemning agricultural lands and maintaining them in the long term.

I would be pleased to discuss any of my comments with you at your convenience. Thank you for giving me the opportunity to provide the Corps with my comments.

If you have any questions or comments, please give me a call at our Miami office.

Sincerely,

Bradley G. Waller,
Principal Hydrologist

BGW:na

ELAINE USHERSON
44 EAST COURT
ROYAL PALM BEACH, FL. 33411
4-3-94

Mr. Stephen Sutterfield,
U.S. Corps of Engineers
P.O. Box 4970.
Jacksonville, FL. 32232-0019
Re: The restoration of the Everglades System and Florida Bay.

I attended the public meeting in Homestead, Florida. I filled out a speakers card however, it was not called when I had to return home to Palm Beach County.

1- I respectfully request that you consider alternative 6A and fill in the C111 Canal south of the retention-detention areas. The timing and distribution in the C111 basin is utmost importance to restore the health of Florida Bay.

2- Please always consider always keeping the natural water elevation in Everglades National Park and All the parks and preserves in the restoration of the Everglade system, including the Loxahatchee Slough in Palm Beach and Martin County. This Slough should Not be permitted to be distroyed (developed) or it too will come back to haunt us.

3. Enforce your Eminent Domaine power to purcha Rocky Glades, Frog Pond and all Real Estate required to restore our Everglade System. There were available land however, those people chose to build in a "lake". They have proffited (most) while "we the people" of South Florida lost. To pay them more than their origional cost would be nothing less than extortion. They have "taken" my source of potable water at reasonable cost, and they have "taken" my native species and threatened and endangered species habitat. (the Wetlands)

Thank you for your dedication. Please consider my input.

Respectfully,
Elaine Usherson

March 27, 1994

Don Black
155 19th Ave S.E.
St Petersburg FL
33705

Mr. Steven Sutterfield:

I first wish to commend the corp on its recommendation of Alternative 6A in restoring natural water levels and historical timing of water into Everglades Nat. Park via Taylor Slough.

As you must know, it is not only the wildlife that will benefit if the glades and water quality are restored, but the whole economic structure of Monroe county will also benefit. And this economic impact of the Keys must be considered in the equation when the discussion of the high cost of the clean up is touted.

As good as alternative 6A is, the restoration has to expand its

over

retention-detention area particularly along C-111N and L-31N to ensure enough clean water for both Taylor and Shark .. sloughs.

Sincerely

Donald A. Black

Brian and Rosalyn Scherf
1060 Tyler Street
Hollywood, FL 33019
(305) 922-5828

April 13, 1994

Mr. Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Sir,

Enclosed are supplementary comments on the proposed modification of C-111 canal network to enhance water flows into Taylor Slough and Florida Bay.

BACKGROUND

The construction of the Central and South Florida Project by the Corps is regarded as the principle factor in the destruction of the Everglades ecosystem. Decades of ditching, draining, and pollution have taken their toll. Florida Bay at the southern most end of the system has seen the dramatic degradation. Some estimates state that freshwater flows into the Bay have declined by 90% from historic levels. There can be no doubt that Florida Bay is critically ill. Among the symptoms:

- An estimated 100,000 acres of seagrass have died.
- Virtually all the sponges in Everglades National Park have died.
- Fish, shrimp, and crab populations have crashed.
- Large algae blooms and sedimentation cloud the once clear water.
- Water salinity has risen to levels much higher than the surrounding ocean.
- The health of the offshore reef is declining, imperiling the whole economy of the Florida Keys.
- Mangroves and other shoreline vegetation are dying.
- Wading bird populations have dramatically declined from historic levels.

Even in it's compartmentalized and degraded condition the Everglades is regarded as a priceless ecological treasure by the international community. The Everglades has been honored by designations as a Wetland of International Significance, a World Heritage Site, and an International Biosphere Reserve. This unique ecosystem, already classified by scientists as being near ecological collapse must undergo an aggressive and visionary restoration program if it is to survive.

Congress has mandated that the Corps undertake studies to restore the Everglades by modifying the Central and South Florida Project. Last November the Science sub-group issued it's report stating the scientific foundation for restoration. This document should serve as the starting point for restoration activities.

OPTION 9

The farmers alternative for the "curtain wall" should be rejected for the following reasons:

- It is too expensive at 180 million.
- Construction of the wall may contaminate underground aquifers with sediment.
- Construction would cause more salt water intrusion compromising well fields.
- Construction would limit restoration options as new ecological data becomes available.

LAND ACQUISITION

According the science subgroup report the "Rocky Glades, the 8.5 square mile area, and Frog Pond" must be purchased under the minimum restoration scenario. These hard choices must be made. Further, additional farm lands in excess of the 11,000 acres may be needed to adequately provide a buffer to restore water flows into Taylor slough.

WATER QUANTITY

A key problem avoided in the draft report is where the additional water will come from. Recent estimates state that at least 500,000 acre feet of water will be needed. A minimum flows and levels study should be included. Water flows should attempt to come close to historic levels, distribution, and timing. The western flow way concept advocated by the National Audubon Society and endorsed by the Everglades Coalition should be implemented. Besides additional links to the C&SFFCP, water conservation measures should be mandated along with a prohibition of further wells in the study area.

C-111 CANAL

The C-111 canal should be filled. It was not originally part of the C&SFFCP and has no useful purpose. Historically the canal has discharged huge slugs of water killing aquatic life and further endangering the American crocodile. While in the short term canals may be needed to distribute water, the goal should be a self-regulating ecosystem with minimum human interference. Canals and other water control structures should be removed over the long term when possible.

Thank you for the opportunity to comment on Florida Bay restoration. Please send us a copy of the final EIS.

Sincerely,

Brian and Rosalyn Scherf

Brian and Rosalyn Scherf

3-29-94

Mr. Stephen Sutterfield
U.S. Army Corps. of Engineers
P.O Box 4970
Jacksonville, Fl. 32232-0019

I am writing to you on the Canal C-111 issue. As a fisherman fishing for fun and to make a living in Fla. Bay, this is very Important to me. I've been watching the bay go downhill since I was a kid. I urge you to return a full natural flow of Clean water to the Bay. We don't need a part. Fix we need a complete fix. If we don't Fix the bay I'm going to lose my livelyhood and be forced out of the keys

Thank You.
Mike Nielsen
11253 3rd Ave
Marathon, Fl 33050
305-743-6212.

421 N.E. 14th St, Homestead FL 33030

Mar. 30/94

Dear Mr. Sutterfield

I have lived in this area (Homestead) since 1978. During this time, I have watched as fewer and fewer birds are nesting in this area. Sometimes there is hardly a trickle of water in what should be a wet area. It has gotten so bad, you can hardly see a bird on Anhinga Trail.

I would say that Everglades National Park as such has hit rock bottom. Another year, and you might as well write it off.

For one thing, they should quit allowing homes to be built in West Broward Co. as they are doing now.

Purchase of Frog Pond Area and Rocky Glades area would help. Also, more water should be allowed in the C-111 canal.

I don't know all the answers, but I do know something must be done fast or forget Everglades National Park.

Sincerely,

Ruth B. Read

Homestead Resident

Yvonne & Fred Harper
P.O. Box 759
Long Key, Fl 33001-0759

March 21, 1994

Mr. Steven Sutterfield
U.S. Corps of Engineers
P.O. Box 4970
Jacksonville, Fl, 32232-0019

Dear Mr. Sutterfield:

We may not be able to attend the March 29th. hearing concerning Florida Bay, but wish to voice our concerns. We are 60 and 62 years of age, respectively, and have been diving in the Middle Keys for 30 years. Since 1971, on a part time basis, and then since 1986 on a full time (seasonal) basis, we've made part of our income from Commercial Lobster Diving. Our activities are concentrated in the Middle Keys near Channel Two, Channel Five and Long Key Bridges.

During the last two seasons, we've been unable to work on many days because of visibility of less than one foot. In some cases, this was a direct result of the Algae Bloom, and in other cases was a result of turbidity being worse, and longer lasting than usual. The die-off of sea grasses in Florida Bay has freed up previously trapped silt so that, after a storm, more silt is suspended in the water, and remains for several days longer.

Our situation may be unique, but many other Commercial Fishermen are also being affected by the Algae Bloom, sea grass and sponge die offs; and consequently adverse conditions. We're afraid we've only seen the beginning of problems as reduced nursery habitat causes continued reduction in available Lobster, Crabs and Finfishes.

While there may be some differing opinions amongst scientists as to the IDEAL methods of restoring the Bay, there seems to be NO DOUBT that improved Fresh Water flow to Florida Bay will be beneficial. Apparently it only took Humans a few decades to create the present unhealthy, unbalanced situation in Florida Bay. Let's hope we've gained the wisdom to START NOW to un-do the mess we've created.

There's no time for more studies. Do whatever it takes to start restoring Florida Bay NOW.

Sincerely,

Yvonne Harper Fred Harper

Norma B. Hamilton
29001 Boyae Road
Punta Gorda, Florida 33982

April 4, 1994

Dear Mr. Sutterfield,

Having read about the various proposals to restore water flow in the Everglades by way of the C-111 project, I would like to express my opinion.

It is apparent that the Everglades is in dire need of corrective action and restoration of more natural water flow. I fully support the Corps choice of alternative 6A. However, I believe that the economic analysis should include the cost of the present and alarming decline in Florida Bay - since there are already many disastrous effects.

I hope the Corps will succeed in effecting enough of the right changes to allow the Everglades to survive.

Thank you,
Norma Hamilton

Pearson Associates
Public Relations and Marketing Consultants

March 26, 1994

MEMORANDUM

TO: Steven Sutterfield

FROM: David Pearson

SUBJ: Florida Bay

As a native of Miami and a member of a pioneer Miami family (my father, Dr. Colquitt Pearson was the first anesthesiologist in South Florida), I would like to go on record on the following:

1. Supporting The Corps' "Alternative 6A" plan to restore fresh water to Florida Bay.

2. Expand the economic analysis for the project to include the cost of the degradation of Florida Bay viz a viz fishing, diving, and tourism.

Thank you for making this a part of the record.

DP/cs
corps.pa

1450 Madruga Avenue, Suite 400, Coral Gables, Florida 33146-3163
Telephone (305) 665-5439 Fax (305) 665-6495

March 25, 1994

Mr Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jax, Fl 32232-0019

Dear Mr. Sutterfield,

I am writing in regard to the C-111 Project.

The economic analysis for this project is flawed because it does not incorporate the cost of the collapse of Florida Bay vs. the benefits of restoring it. The degradation of Florida Bay has endangered the economy of the entire Florida Keys which is based in large part on fishing and diving. Scientists agree restoration of freshwater flows is absolutely essential to restoration of the Bay. Since the C-111 area is a key avenue for inflow of fresh-water into Florida Bay, the benefits of economic recovery to these industries in Florida Bay should be quantified and will add additional economic justification for restoring historic conditions.

Sincerely,

Quincie A. Locke (mrs.)

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

With great concern I have watched the gradual destruction of the East Everglades eco-system and the fisheries of Florida Bay. I see hope for the restoration of the East Everglades in option 6A as proposed by the Corps of Engineers.

I welcome the proposed purchase of the lands adjacent to the Park, known as the "Frog Pond" and the "Rocky Glades." The proposed retention/detention area on these lands is essential to the restoration of water quality in the South East Glades.

May I suggest that proper control of storm water run-off from Homestead and Florida City will require a pump of 500cfs capacity rather than the 50 cfs pump proposed at S-332B. Further an expanded reservoir area along the west side of L-31N will do much to guarantee clean water under timely control to Taylor Slough and the Shark River Valley in Everglades National Park.

I have great confidence that, with the support of the people of Florida, the Corps of Engineers will develop and implement a practical plan for restoration of the South East Everglades and Florida Bay.

Sincerely,

Ann Pierce Horn
3094 Cady Road
Boca Raton, Fl. 33432

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

With great concern I have watched the gradual destruction of the East Everglades eco-system and the fisheries of Florida Bay. I see hope for the restoration of the East Everglades in option 6A as proposed by the Corps of Engineers.

I welcome the proposed purchase of the lands adjacent to the Park, known as the "Frog Pond" and the "Rocky Glades." The proposed retention/detention area on these lands is essential to the restoration of water quality in the South East Glades.

May I suggest that proper control of storm water run-off from Homestead and Florida City will require a pump of 500cfs capacity rather than the 50 cfs pump proposed at S-332B. Further an expanded reservoir area along the west side of L-31N will do much to guarantee clean water under timely control to Taylor Slough and the Shark River Valley in Everglades National Park.

I have great confidence that, with the support of the people of Florida, the Corps of Engineers will develop and implement a practical plan for restoration of the South East Everglades and Florida Bay.

Sincerely,

K. Cartier
5260 N.W. 2nd Av
Boca Raton, Fl. 33487

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

With great concern I have watched the gradual destruction of the East Everglades eco-system and the fisheries of Florida Bay. I see hope for the restoration of the East Everglades in option 6A as proposed by the Corps of Engineers.

I welcome the proposed purchase of the lands adjacent to the Park, known as the "Frog Pond" and the "Rocky Glades." The proposed retention/detention area on these lands is essential to the restoration of water quality in the South East Glades.

May I suggest that proper control of storm water run-off from Homestead and Florida City will require a pump of 500cfs capacity rather than the 50 cfs pump proposed at S-332B. Further an expanded reservoir area along the west side of L-31N will do much to guarantee clean water under timely control to Taylor Slough and the Shark River Valley in Everglades National Park.

I have great confidence that, with the support of the people of Florida, the Corps of Engineers will develop and implement a practical plan for restoration of the South East Everglades and Florida Bay.

Sincerely,

Judith C. Weigand
1583 S.W. 5th Ave
Boca Raton, FL 33432

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

With great concern I have watched the gradual destruction of the East Everglades eco-system and the fisheries of Florida Bay. I see hope for the restoration of the East Everglades in option 6A as proposed by the Corps of Engineers.

I welcome the proposed purchase of the lands adjacent to the Park, known as the "Frog Pond" and the "Rocky Glades." The proposed retention/detention area on these lands is essential to the restoration of water quality in the South East Glades.

May I suggest that proper control of storm water run-off from Homestead and Florida City will require a pump of 500cfs capacity rather than the 50 cfs pump proposed at S-332B. Further an expanded reservoir area along the west side of L-31N will do much to guarantee clean water under timely control to Taylor Slough and the Shark River Valley in Everglades National Park.

I have great confidence that, with the support of the people of Florida, the Corps of Engineers will develop and implement a practical plan for restoration of the South East Everglades and Florida Bay.

Sincerely,

680 LAWRENCE
DELRAY 33445

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

With great concern I have watched the gradual destruction of the East Everglades eco-system and the fisheries of Florida Bay. I see hope for the restoration of the East Everglades in option 6A as proposed by the Corps of Engineers.

I welcome the proposed purchase of the lands adjacent to the Park, known as the "Frog Pond" and the "Rocky Glades." The proposed retention/detention area on these lands is essential to the restoration of water quality in the South East Glades.

May I suggest that proper control of storm water run-off from Homestead and Florida City will require a pump of 500cfs capacity rather than the 50 cfs pump proposed at S-332B. Further an expanded reservoir area along the west side of L-31N will do much to guarantee clean water under timely control to Taylor Slough and the Shark River Valley in Everglades National Park.

I have great confidence that, with the support of the people of Florida, the Corps of Engineers will develop and implement a practical plan for restoration of the South East Everglades and Florida Bay.

Sincerely,

Simone Spiess
SIMONE SPIESS
Blvd

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

With great concern I have watched the gradual destruction of the East Everglades eco-system and the fisheries of Florida Bay. I see hope for the restoration of the East Everglades in option 6A as proposed by the Corps of Engineers.

I welcome the proposed purchase of the lands adjacent to the Park, known as the "Frog Pond" and the "Rocky Glades." The proposed retention/detention area on these lands is essential to the restoration of water quality in the South East Glades.

May I suggest that proper control of storm water run-off from Homestead and Florida City will require a pump of 500cfs capacity rather than the 50 cfs pump proposed at S-332B. Further an expanded reservoir area along the west side of L-31N will do much to guarantee clean water under timely control to Taylor Slough and the Shark River Valley in Everglades National Park.

I have great confidence that, with the support of the people of Florida, the Corps of Engineers will develop and implement a practical plan for restoration of the South East Everglades and Florida Bay.

Sincerely,

Elayne Fortgang
7828 Mansfield Holl

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

With great concern I have watched the gradual destruction of the East Everglades eco-system and the fisheries of Florida Bay. I see hope for the restoration of the East Everglades in option 6A as proposed by the Corps of Engineers.

I welcome the proposed purchase of the lands adjacent to the Park, known as the "Frog Pond" and the "Rocky Glades." The proposed retention/detention area on these lands is essential to the restoration of water quality in the South East Glades.

May I suggest that proper control of storm water run-off from Homestead and Florida City will require a pump of 600cfs capacity rather than the 50 cfs pump proposed at S-332B. Further an expanded reservoir area along the west side of L-31N will do much to guarantee clean water under timely control to Taylor Slough and the Shark River Valley in Everglades National Park.

I have great confidence that, with the support of the people of Florida, the Corps of Engineers will develop and implement a practical plan for restoration of the South East Everglades and Florida Bay.

Sincerely,

Martin J. Fortgang
MARTIN J. FORTGANG
7828 MANSFIELD HOLLOW
DELRAY BEACH, FL 33446
407-495-5015

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

With great concern I have watched the gradual destruction of the East Everglades eco-system and the fisheries of Florida Bay. I see hope for the restoration of the East Everglades in option 6A as proposed by the Corps of Engineers.

I welcome the proposed purchase of the lands adjacent to the Park, known as the "Frog Pond" and the "Rocky Glades." The proposed retention/detention area on these lands is essential to the restoration of water quality in the South East Glades.

May I suggest that proper control of storm water run-off from Homestead and Florida City will require a pump of 500cfs capacity rather than the 50 cfs pump proposed at S-332B. Further an expanded reservoir area along the west side of L-31N will do much to guarantee clean water under timely control to Taylor Slough and the Shark River Valley in Everglades National Park.

I have great confidence that, with the support of the people of Florida, the Corps of Engineers will develop and implement a practical plan for restoration of the South East Everglades and Florida Bay.

Sincerely,

[illegible]
161 NE Harbour Terr
Boca Raton, FL 33431

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

With great concern I have watched the gradual destruction of the East Everglades eco-system and the fisheries of Florida Bay. I see hope for the restoration of the East Everglades in option 6A as proposed by the Corps of Engineers.

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I have great confidence that, with the support of the people of Florida, the Corps of Engineers will develop and implement a practical plan for restoration of the South East Everglades and Florida Bay.

Sincerely,

[illegible]
6035 S Verde Trl J315
Boca Raton FL

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

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Sincerely,

[illegible]
5657 Willow Creek Lane

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

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I have great confidence that, with the support of the people of Florida, the Corps of Engineers will develop and implement a practical plan for restoration of the South East Everglades and Florida Bay.

Sincerely,

Mary E. Boyd F-302
950 Lavers Circle
Delray Bch, Fl. 33444

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

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Sincerely,

Mary M Zahner
6035 S Verde Trl J315
Boca Raton FL 33433

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

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Sincerely,

Kathryn Boyd
950 Sonos Circle #302
Delray Beach, Fla. 33444

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

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Sincerely,

Alan K. Parmelee
4765 N.W. 6th CT.
DELRAY BCH FL. 33445

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

With great concern I have watched the gradual destruction of the East Everglades eco-system and the fisheries of Florida Bay. I see hope for the restoration of the East Everglades in option 6A as proposed by the Corps of Engineers.

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Sincerely,
[illegible]

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

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Sincerely,
Al Kaminske
22305 General St
Boca Raton Fla 33428

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

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I have great confidence that, with the support of the people of Florida, the Corps of Engineers will develop and implement a practical plan for restoration of the South East Everglades and Florida Bay.

Sincerely,

Elisabeth Hoffman
4307 NW 5th Avenue
Boca Raton FL 33431

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

With great concern I have watched the gradual destruction of the East Everglades eco-system and the fisheries of Florida Bay. I see hope for the restoration of the East Everglades in option 6A as proposed by the Corps of Engineers.

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I have great confidence that, with the support of the people of Florida, the Corps of Engineers will develop and implement a practical plan for restoration of the South East Everglades and Florida Bay.

Sincerely,

MARY IRVING 690 LAWRENCE
DERAY FL
33445

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

With great concern I have watched the gradual destruction of the East Everglades eco-system and the fisheries of Florida Bay. I see hope for the restoration of the East Everglades in option 6A as proposed by the Corps of Engineers.

I welcome the proposed purchase of the lands adjacent to the Park, known as the "Frog Pond" and the "Rocky Glades." The proposed retention/detention area on these lands is essential to the restoration of water quality in the South East Glades.

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Sincerely,

Marguerite Jacobson
701 N.E. Harbourville ...
Boca Raton, Fla
33431

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

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I welcome the proposed purchase of the lands adjacent to the Park, known as the "Frog Pond" and the "Rocky Glades." The proposed retention/detention area on these lands is essential to the restoration of water quality in the South East Glades.

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Sincerely,

Esther Becht
6252 Stanley Lane
Delray Beach FL 33484

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

With great concern I have watched the gradual destruction of the East Everglades eco-system and the fisheries of Florida Bay. I see hope for the restoration of the East Everglades in option 6A as proposed by the Corps of Engineers.

I welcome the proposed purchase of the lands adjacent to the Park, known as the "Frog Pond" and the "Rocky Glades." The proposed retention/detention area on these lands is essential to the restoration of water quality in the South East Glades.

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I have great confidence that, with the support of the people of Florida, the Corps of Engineers will develop and implement a practical plan for restoration of the South East Everglades and Florida Bay.

Sincerely,

Hugh Benton
5800 CAMINO DEL SOL #302
Boca Raton Florida 33433

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

With great concern I have watched the gradual destruction of the East Everglades eco-system and the fisheries of Florida Bay. I see hope for the restoration of the East Everglades in option 6A as proposed by the Corps of Engineers.

I welcome the proposed purchase of the lands adjacent to the Park, known as the "Frog Pond" and the "Rocky Glades." The proposed retention/detention area on these lands is essential to the restoration of water quality in the South East Glades.

May I suggest that proper control of storm water run-off from Homestead and Florida City will require a pump of 500cfs capacity rather than the 50 cfs pump proposed at S-332B. Further an expanded reservoir area along the west side of L-31N will do much to guarantee clean water under timely control to Taylor Slough and the Shark River Valley in Everglades National Park.

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Sincerely,

Ingeborg T. J. Benton
5800 Camino Del Sol, #302
Boca Raton, FL 33433

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

With great concern I have watched the gradual destruction of the East Everglades eco-system and the fisheries of Florida Bay. I see hope for the restoration of the East Everglades in option 6A as proposed by the Corps of Engineers.

I welcome the proposed purchase of the lands adjacent to the Park, known as the "Frog Pond" and the "Rocky Glades." The proposed retention/detention area on these lands is essential to the restoration of water quality in the South East Glades.

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Sincerely,

Carole Cartier
1260 N.W. 2nd Ave
Unit 701
Boca Raton, Fla. 33487

April 14, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

With great concern I have watched the gradual destruction of the East Everglades eco-system and the fisheries of Florida Bay. I see hope for the restoration of the East Everglades in option 6A as proposed by the Corps of Engineers.

I welcome the proposed purchase of the lands adjacent to the Park, known as the "Frog Pond" and the "Rocky Glades." The proposed retention/detention area on these lands is essential to the restoration of water quality in the South East Glades.

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Sincerely,

Sara S. Stalles
161 NE Wavecrest Way
Boca Raton FL 33432

Lawrence M. Porter
28 Ocoa Court, Route 23
Jamaica Bay West
Ft. Myers, FL 33912

26 Mar 94

Mr Steven Sutterfield;
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL, 32232-0019

Dear Mr. Sutterfield:

In regard to the proposed C-111 project to restore flows into Taylor Slough and Florida Bay; I am in favor of Alternative 6A with some improvements.

1. Purchase the Frog Pond and Rocky Glades agricultural area.
2. Construct the retention/detention area in Rocky Glades and the Frog Pond.
3. Fill or plug canal C-111 to prevent agricultural and urban Run off.
4. To ensure flood protection to communities to the North, and restore historic timing and distribution of sheetflow designate and design the proposed C-111N canal as a retention/detention area lim to the area to the North.

II

5. use a 500 CFS pump instead of a . CFS one at S-332B so that wat pumped into a large retention/dete area along C111N will allow a natural sheetflow South.
6. Expand the retention/detention ar along the West side of L-31N nor of the Tamiami Trail as sugge by alternative #8 to ensure c water patterns for Shark Valley Taylor Slough.
7. Extend C111N East of US 1 f Maximum flexibility and wate delivery to all parts of this system.

Now is the time to get this system operating as it shoul. Tomorrow will be too late.

Sincerely
Lawrence M Porter F
Caloosa Bird Club

March 28, 1984

Dear Mr Sutterfield

I am writing to you because I am unable to attend the public meeting in Homestead tomorrow (3-29)

I am in favor of . Alternative 6A . I feel that it is a good proposal that could be improved by: filling C 111 canal, which would eliminate the poisoning of Barnes Sound with slugs of agricultural and urban runoff

2. The proposed C-111N canal should be designed as a retention/detention area linked to the North. This would restore historic timing and distribution of sheetflow in this part of the Everglades while also helping to insure flood protection to communities to the North.

3. The Corps should use a 500 CFS pump at S-332B so that the waters are pumped into a large retention/detention area along

2.

C-111N which would allow the sheetflow to move through the Everglades into Florida Bay. Pro ecological Benefits as well as gr flood protection.

4. Expand the retention/deten area along the West side of As suggested by alternative 6

5. Lastly C111N - Should be E of US1 to allow maximum and water deliveries to all part this system

This system and its water ment policies must be overhau to prevent overdraining of Everglades & ~~[illegible]~~ further end of to Florida Bay.

Hold fast to restoring Taylor Slough & Florida Bay. Do Be pressured by the Agri bu interests into doing nothing. Area must be saved!

Thank you

Jeanne Girard

2641 Gately D. W

WPB Fl 33415

[redacted]

March 31, 1994

Mr. Steven Sutterfield
US Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield:

I have always been vitally interested in the protection of the environment. Certainly the proper protection of the Floida Everglades is of vital importance to the well-being of the state of Florida. I believe a proper balance must be sought between the operations of the industrial community and the maintenance of the health of the Everglades.

I have been following closely over several years, actions that have taken place in sections of the Everglades. Problems in the management system over the past ten years have been aggravated by practises that have over-drained the Everglades, preventing water from flowing into Florida Bay. This has been done to benefit a few tomato growers in the so called Frog Pond area. Such action has done visible and significant harm to the Everglades and Florida Bay through preventing fresh water flow from reaching key parts of the Bay.

Of the various plans relative to restoring of fresh water flow to restore Florida Bay, Alternative 6-A seems to have much merit. However, after considerable thought on the matter, I would like to offer some improvements as per the following: (See next page)

1. To more fully ensure flood protection to communities to the north, as well as restore distribution of sheetflow in this part of the Everglades, the proposed C111N canal should be designed as a retention/detention area linked to the area to the north.

2. The Corps should use a 500 cfs pump instead of a 50 cfs one at S-332B so that waters are pumped into large retention/detention area along C-111N which allows natural sheetflow to move down through the southern Evergladesarea into the marine environment. This should provide some ecological benefits while allowing greater flood protection as well.

3. Expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested by Alternative 8. Only by this action will the Corps ensure that enough clean water can be made available in both Shark Slough and Taylor Slough.

4. C-111N should be extended east of US I to allow maximum flexibility and water deliveries to all parts of the system.

Respectfully,

Richard E. Marshall

Richard E. Marshall

11076 Alumni Way
Jacksonville, Fl 32246
March 28, 1994

Dear Mr. Sutterfield,

I am writing regarding Alternative 6A to restore flows into Taylor Slough and Florida Bay.

First, the economic analysis is flawed because it does not incorporate the cost of the collapse of Florida Bay i.e. the benefits of restoring it. The collapse endangers the economy of the entire Florida Keys.

I would like to see the purchase of the Frog Pond and Rocky Glades agricultural area since this is essential to the future of the Everglades / Fl Bay system.

The proposed retention/detention area, in what is now the Rocky Glades and Frog Pond is essential to ensuring water quality + flood control.

The proposed C-111N Canal should be designed as a retention/detention area linked to the area to the north. C-111N also should be extended east of US1 to allow maximum flexibility & water deliveries to all parts of this system.

Expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested by Alternative 8 to allow enough clean water for both Shark Slough and Taylor Slough.

Lastly, the corp should use a 500 cfs pump instead of a 50 cfs one at S-332B so that waters are pumped into a large retention/detention area along C-111N which allows natural sheetflow to move down through the southern Everglades area into the marine environment. This provides ecological benefits while allowing for greater flood protection as well.

Thank you for your consideration

Sincerely,
Anne D. Kennedy-Turner

30 March 1994

Mr Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr Sutterfield,

A few comments on the proposed C-111 Project. The economics analysis for this project is possibly flawed because it does not incorporate the cost of the collapse of Florida Bay vs. the benefits of restoring it. The degradation of Florida Bay has endangered the economy of the entire Florida Keys which is based in large part on fishing and diving. Scientists agree restoration of freshwater flows is absolutely essential to restoring the Bay. Since the C-111 area is a key avenue for input of freshwater into Florida Bay, the benefits of economic recovery to those industries in Florida Bay should be quantified and could add additional economic justification for restoring historic conditions.

In the last decade farmers in the Frog Pond area have successfully prevailed upon the government to give them more and more drainage benefits not provided by law. By providing these benefits, the Corps and District have harmed the Park and Bay because when Frog Pond is drained also drained is the adjacent marshes in Taylor Slough. Therefore, purchase of the Frog Pond and Rocky Glade agricultural area contemplated by this proposal is essential to the future of the Everglades system.

The proposed retention/detention area, in what is now the Rocky Glades and Frog Pond, is essential to ensuring water quality in this area as well as providing flood control for areas east of L-31/C-111 canals.

While Alternative 6A is a good one, it is my belief it can be improved in the following ways

- To more fully ensure flood protection to communities to the north, as well as restore historic timing and distribution of sheetflow in this part of the Everglades, the proposed C-111 N canal should be designed as a retention/detention area linked to the area to the north.

- The Corps should use a 500 cfs pump instead of a 50 cfs one at S-332 B so that waters are pumped into a large retention/detention area along C-111 N which allows natural sheetflow to move down through the southern Everglades area into the marine environment. This provides ecological benefits while allowing for greater flood protection as well.

- Expand the retention/detention area along the west side of L-31 N north to Tamiami Trail as suggested by Alternative 8. Only by doing this will the Corps ensure that enough clean water can be made available in historic patterns for both Shark Slough and Taylor Slough.

- C-111 N should be extended east of U.S. 1 to allow maximum flexibility and water deliveries to all parts of this system.

Thank you for your concern and attention in this matter.

Sincerely
Robert E Rutkowski

2527 Faxon Court
Topeka, Kansas
66605-2086

SIERRA CLUB

BROWARD COUNTY GROUP

April 17, 1994

Larry Marvet
Conservation Vice-Chair
5561 SW 7th Street
Plantation, Florida 33317
(305)321-5753

Stephen Sutterfield
US Army Corps Of Engineers
P O Box 4970
Jacksonville, FL. 32232-0019

Dear Mr. Sutterfield,

I attended the meeting in Homestead on March 29 concerning the proposed C-111 project which promises to improve the flow into Taylor Slough and Florida Bay. I was struck by the nearly unanimous agreement, among farmers, environmentalists, residents and politicians that Florida Bay should be saved. I congratulate the Corps efforts to bring the affected parties to this position.

The Broward County Group of Sierra Club generally agrees with your plan 6A and strongly believes that Alternative 9 is seriously—dangerously—flawed. You chose correctly and we strongly urge you to reject further attempts to change your choice to Alternative 9.

However, 6A can and should be improved. First, hydroperiod can be improved by replacing C-111N by a retention/detention area which accepts stormwater runoff from Homestead and Florida City. Secondly, the pump at S-332E should be sized at 500 cubic feet per second, rather than the proposed 50 cfs, so that the stormwater runoff mentioned above can be pumped to the retention/detention area instead of being routed through the C-111 to the ocean and causing the kind of marine disasters we've seen too often in the past. Next, these new retention/detention areas should be extended east of US-1 to optimize water deliveries to all parts of the area, including coastal Everglades. Additionally, we believe that the C-111 should be filled south of the retention/detention areas. Finally, expansion of the retention/detention area along the west side of L-31N and north to the Tamiami will insure that water is available to both Shark Slough and Taylor Slough in the required quantities.

Please keep up the good work, but don't miss this opportunity to make the aforementioned improvements to your plan.

Sincerely,

Larry Marvet

Larry Marvet
Conservation Vice-Chair

Recycled Paper

Richard H. Spencer
6152 N. Verde Trail E116
Boca Raton, Fl. 33433
Phone: 407 479-4651

April 13, 1994

Mr. Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Fl. 32232-0019

Subject: Support of Canal 111 Project, Alternative 6A

Dear Sutterfield:

As a resident of south Florida for over a quarter of a century, I deplore what has happened, and is continuing to happen, to our everglades and Florida Bay. I heartily support your efforts to restore and enhance the flow of fresh water to those areas by implementation of the subject project.

A. Following are some specifics that I endorse as being significant to the success of the project:

1. Purchase of Frog Pond and Rocky Glades agricultural area
2. Identify the cost of Florida Bay collapse vs restoration cost - both pieces are needed for true evaluation.

B. Following are some suggestions for enhancement of Alternative 6A and its implementation:

1. To more ensure flood protection north, as well as restore the sheet flow to the south, design the proposed Canal 111N to be a retention/detention area linked to the area north.
2. To allow and enhance sheetflow south, increase the pump size from 50 cfs to 500cfs at S-332B to pump water into a large retention/detention area along the C111N.
3. To ensure adequate clean water for Clark and Taylor Sloughs, it is suggested that the retention/detention area along the west side of L-31N, north to Tamiami Trail be expanded.
4. Extension of C111N east across U.S. Hwy. 1 would enhance flexibility and area delivery coverage for the system.

With appreciation for the Corps' proposal and attention to this matter.

Respectfully,

R. H. Spencer

Richard H. Spencer

April 13, 1994
6941 S. Shore Dr.
S. Pasadena, FL
3370

Mr. Steven Sutterfield
U.S. Corps of Engineers
P.O. Box 4970,
Jacksonville, FL 32232-0019

Dear Steven Sutterfield:

I am unable to attend the public meeting on March 29th in Homestead, but I am nevertheless very interested in restoring the Everglades. The management of the region certainly has had its flaws.

I approve of Alternative 6A if it will do the following things:

(1) Extend C-111N east of US 1 for maximum flexibility and flow delivery to all parts of the system.

(2) Expand the retention/detention along the west side of L-31 North to Tamiami Trail (alternative 8). Clean water will then be available for Shark Slough and Taylor Slough.

(3) Use a larger pump (500 cfs) instead of the 50 cfs at S-333 B so that waters are pumped into larger retention area along C-111N. This will allow a natural flow through the southern Everglades. It will allow for ecological benefits and greater flood protection.

(4) The proposed C-111N canal should be designed as a retention/detention area added to the areas to the North to provide these communities flood protection.

Hoping that you will give my letter full consideration.

Sincerely yours,
Estelle Dunslow

Mr. David Sapir APT. 51
2101 Atlantic Shores Blvd.
Hallandale, FL 33009-2857

March 30th 1994.

Mr. Steven Sutterfield

Have looked-up "Sutter" and found that a Mr. John Augustus Sutter (1808-1880) had a mill in eastern Cal., where gold was discovered in 184[illegible] Any relationship? What is or was a Sutter?

Dear sir, Greetings,

I have read and understood "the flyer" I'm sending. I fully agree that "Alternative 6A" is the way to go and can be much improved by following the recommendations of the (4) red encircled improvements. Please except my thanks.

David Sapir.

AUDUBON SE REGIONAL OFFICE

ACTION ALERT

NATIONAL AUDUBON SOCIETY

MARCH 18, 1994

Urgent Everglades/Florida Bay Action Alert

The US Army Corps of Engineers is holding a hearing on restoring flows into Taylor Slough and Florida Bay through the proposed C-111 Project.

March 29, 1994
7:00 pm
Homestead High School
351 S.E. 12 Street
(East of Hwy 1)
For information about buses, call Theresa Ashley at (305) 296-3880

Background: C-111 is in the far southeast region of the Everglades system. It is the key area for providing overland flows into southeastern portion of Everglades National Park and the northeast corner of Florida Bay. This area provides important habitat for endangered species such as the Wood Stork, Cape Sable Sparrow, American Crocodile and the Snail Kite. However, the ditching and draining of this area has disrupted the natural timing, distribution and flow of water. Instead of a gentle sheet of water, fed by rain, moving slowly through this area, canals drain water out of marshes and quickly out of the system. In the last decade problems in the system have been aggravated by water management practices which have overdrained the Everglades and prevented water from going into Florida Bay - all to benefit a few tomato growers in the area known as the Frog Pond. This over draining has done visible and significant harm to the Everglades/Florida Bay and prevented vital freshwater flows from reaching the key areas of the Bay.

How you can help:

1. Attend the public hearing on March 29
2. Attend the public hearing on March 29 and write a letter to the Corps of Engineers
3. Write a letter to the corps of engineers

You can help by attending the public hearing at Homestead on the 29th. It is clear that the agricultural community intends to turn out many of its workers to oppose this restoration project and is using scare tactics to recruit homeowners from other areas of South Dade County. If you can't attend the hearing then please submit written comments, prior to April 20, 1994, to:

Mr. Steven Sutterfield
US Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

What the Corps proposes: This project is being undertaken to select a plan to increase the operational capability and flexibility of the C-111 system to provide restoration for the ecological integrity of Taylor Slough and the eastern panhandle area of the Everglades. The project must maintain existing authorized levels of flood protection for agricultural interests adjacent to C-111. Restoration of these flows will provide freshwater necessary for restoring Florida Bay. The

The Corps reviewed 10 alternatives including a no action alternative, and alternatives 1-6A, 8 and 9. The Corps found that alternative 6A met all of the criteria to provide operational flexibility for this part of the system. The tomato farmers offered Alternative 9 which did not provide flexibility to restore natural water levels along the boundary and headwaters of upper Taylor Slough or to control the timing flows into Taylor Slough - essential to the restoration of historic flows in this area. The Corps noted that Alternative 6A provides the same amount of flood protection as the farmers proposal. The Corps chose Alternative 6A because it provides the greatest benefit to the environment, maximizes operational flexibility and provides flood damage prevention capability to agriculture.

Points you can make about the proposal:

- The economic analysis for this project is flawed because it does not incorporate the cost of the collapse of Florida Bay vs. the benefits of restoring it. The degradation of Florida Bay has endangered the economy of the entire Florida Keys which is based on large part on fishing and diving. Scientists agree restoration of freshwater flows is absolutely essential to restoration of the Bay. Since the C-111 area is a key avenue for input of freshwater into Florida Bay, the benefits of economic recovery to these industries in Florida Bay should be quantified and will add additional economic justification for restoring historic conditions.

- In the last decade farmers in the Frog Pond area have successfully prevailed upon the government to give them more and more drainage benefits not provided by law. By providing these benefits, the Corps and District have harmed the Park and Florida Bay, because when they drain the Frog Pond they also drain the adjacent marshes in Taylor Slough. Therefore, purchase of the Frog Pond and Rocky Glades agricultural area contemplated by this proposal is essential to the future of the Everglades/Florida Bay system.

- The proposed retention/detention area, in what is now the Rocky Glades and Frog Pond, is essential to ensuring water quality in this area as well as providing flood control for areas east of L-31/C-111 canals.

- While Alternative 6A is a good one it can be improved in the following ways.

  - To more fully ensure flood protection to communities to the north, as well as restore historic timing and distribution of sheetflow in this part of the Everglades, the proposed C-111N canal should be designed as a retention/detention area linked to the area to the north.

  - The Corps should use a 500 cfs pump instead of a 50 cfs one at S-332B so that waters are pumped into a large retention/detention area along C-111N which allows natural sheetflow to move down through the southern Everglades area into the marine environment. This provides ecological benefits while allowing for greater flood protection as well.

  - Expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested by Alternative 8. Only by doing this will the Corps ensure that enough clean water can be made available in historic patterns for both Shark Slough and Taylor Slough.

  - C-111N should be extended east of US 1 to allow maximum flexibility and water deliveries to all parts of this system.

April 14, 1994

Mr. Steven Sutterfield
U.S. Army Corps of Engineers
P.O. 4970
Jacksonville, Fl 32232-0019

Re: Restoring Water Flow into Taylor Slough and Florida Bay through the Proposed C-111 Project

Dear Mr. Sutterfield:

I support the restoration project to improve the flow of water into Florida Bay, having seen first hand the seriousness of the water quality problem.

I believe the 6A alternative is the best, but could be improved by completely plugging the C-111 canal to prohibit urban runoff and varying amounts of fresh water from disturbing the balance in Barnes Sound. The C-111N canal should be designed to retain water and extended to east of US 1 and larger pumps should be in place to provide for greater water distribution and allow the natural sheetflow to move water down through the souther Everglades area into Florida Bay. Additionally, the retention area along the west side of L-31N should be expanded to allow for greater flow for Shark Valley slough and Taylor Slough.

While I realize that many of these proposals will jeopardize various existing interests, the long-range water picture must be factored into the decisions made. There are many more upstream and downstream interests as well as future water demands to be considered. Our watershed (the Everglades) must be protected and sacrifices must be made now.

Sincerely,

Karen Young

Karen Young
901 Placetas Ave.
Coral Gables, Fl 33146

il 11, 1994

Army Corps of Engineers
› Mr. Stephen Sutterfield
› Box 4970
:ksonville, FL 32232-0019

ır Mr. Sutterfield:

: proposed project to increase the operational capability and
:xibility of the Canal #111 (C-111) is long overdue. This canal
ıaged Florida Bay by dumping stormwater into the Bay during heavy
ins and flood events and draining nearby marshes at time of
ıught for agricultural purposes.

the last decade farmers in the Frog Pond area have successfully
evailed in receiving more drainage benefits than provided by law
the expense of the Everglades. Drainage of Frog Pond also
ains the adjacent marshes in Taylor Slough. The current
ndition of the Slough displays that this agricultural use is
compatible with a healthy Bay. The Corps must purchase this land
d the Rocky Glades agricultural area to insure the future health
Florida Bay and The Everglades.

th the approval of the Everglades Restoration Plan by the Florida
gislature, the Corps is afforded an excellent opportunity to
ntribute to this Plan by restoring the historic sheetflow to the
utheastern Everglades. The creation of a water retention/
tention area instead of the proposed C-111N would better
complish this goal. This would provide full flood protection and
establish the natural sheetflow without destroying the marine
vironment.

e retention areas prevent unnatural water flows into the Bay and
ould be expanded along the west side of L-31N north to Tamiami
ail as suggested by Alternative 8. The Corps could achieve
ximum flexibility and water deliveries to the coastal Everglades
extending the retention area east of US Highway 1. The return
the natural sheetflow to Shark Slough and Taylor Slough will
low the Everglades to filter water flows into Florida Bay and
lp restore the ecological cycle that has been disrupted.

incerely,

arold Hancock, 5848 NW 21st Street, Lauderhill, FL 33313

Christopher D. Koss

Mr. Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

April 10, 1994

Dear Mr. Sutterfield:

May I please add my wholehearted support to your proposal alternative 6A for the Everglades/Florida Bay Restoration.

I believe that proposal could be enhanced by linking Canal 111N to the north, which would help in the distribution of sheet flow in this part of the Everglades.

Further, a much-larger pump at S-332B would enable more effective retention and detention along C-111N.

Expansion of the retention area along the west side of L-31N, as suggested in Alternative 8, would allow enough clean water for both Shark and Taylor Sloughs.

By extending Canal 111N east of Highway 1, maximum flexibility and water delivery would be provided for the entire system.

Sincerely yours,

881 Ocean Drive #17E Key Biscayne, Florida 33149

Allen D Rios
2233 Nowry LN
kissimmee, FL 34741

Mr. Steven Sutterfield
US Army Corps of Engineers
P.O. Box 4970
Jacksonville. FL 32232-0019

Dear Mr. Sutterfield,

I am writing you to submit my comments on the proposed C-111 progect. As you know the C-111 project area is the key area for providing overland flows into southeastern portion of Everglades National Park and the northeastern corner of Florida Bay.This area provides inportant habitat for endangered species such as Wood Stork,Cape Sable Sparrow, American Crcidile and theSnail Kite. I would like to hit on a few points about the overall praposal.

* THe economic analysis for this project is flawed because it does not incorperate the cost of the collapse of Florida Bay vs. the benifits of restoring it. the degradation of Florida Bay has endangered the the economy of the intire Florida Keys which is based in large part to diving and fishing.

*In the last decade farmers in the Frog Pond area have been given more and more drianage benifets not provided by law.By providing these benefits the Corps and District have harmed the Park and Florida Bay, because when they drain the Frog Pond they also drian the marshes in the adjacent Taylor Slough. THerefore, the purchase of the Frog Pond and Roccky Glades agriculteral area is essential to to the future of the Everglades/Florida Bay system.

* THe proposed retention/detention area, in what is now the Rocky glades and Frog Pond, is essential to ensuring water quality in this area as well as providing flood control for areas east of L-31/C-111 canals

Of the ten alternatives reviewed by the Corps, 6A is the best alternitive, but it can be inproved in the following ways.

* To more fully insure flood control, as well as restore historic timing and distribution of sheetflow in this part of the Everglades,the proposed C-111N canal should be designated as a retention/detention area linked to the area to the north.

*The Corps should use a 500 cfs pump instead of a 50 cfs one at S-332B

(over)

* Expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested by alternitive 8.

*C-111N should be exstended east of US-1 to allow maximum flexibility and water deliveries to all parts of this system.

Thank you for allowing me to submit these comments.I hope you take into account the points I have listed, and implement alternative 6A with the inprovements I have suggested.

Sincerly,

Allen D.RIos
2233 nowry LN
Kissimmee, FL 34741
(407) 933-1797

Catherine VerSchneider
638 Snug Harbor Drive #15
Boynton Beach, FL 33435

April 10, 1994

Mr. Steven Sutterfield
US Army Corps of Engineers
PO Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield:

Restoring flows into Taylor Slough and Florida Bay through the C-111 Project must incorporate the cost of the collapse of Florida Bay versus the benefits of restoring it. The degradation of Florida Bay has endangered the economy of the entire Florida Keys, which depends on the quality of the water resource. Scientists agree that restoration of the freshwater flows is absolutely essential to the restoration of the Bay. Since the C-111 area is a key avenue for input of freshwater into the Florida Bay, the benefits of economic recovery to fishing and diving industries should be quantified, thereby increasing economic justification for restoring historic conditions.

In the last decade, farmers in the Frog Pond area have successfully prevailed upon the government to give them more and more drainage benefits not provided by law. By providing these benefits, the Corps and District have harmed the Park and Florida Bay., as draining Frog Pond also drains adjacent marshes in Taylor Slough. Therefore, purchase of Frog Pond and Rocky Glades agricultural area, as contemplated by the proposal, is essential for the future of the Everglades/Florida Bay system.

The proposed retention/detention area, in what is now Frog Pond and Rock Glades, is requisite for ensuring water quality in this area , as well as providing flood control for areas east of L-31/C-111 canals.

The Corps chose Alternative 6A because it provides the greatest benefit to the environment, maximizes operational flexibility, and provides flood damage prevention capability to agriculture. Alternative 6A can be improved in the following ways:

1. For better flood protection to communities to the north, and restore historic timing and distribution of sheetflow in this part of the Everglades, the proposed C-111N canal should be designated as a detention/retention area linked to the area to the north.

2. The Corps should use a 500 cfs pump (not 50 cfs) at S-332B so that waters are pumped into a large retention/detention area along C-111N which allows natural sheetflow to move down through the southern Everglades area into the marine environment.

3. Expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested by Alternative 8. Only by doing this will the Corps ensure that enough clean water can be made available in historic patterns for both Shark Slough and Taylor Slough.

4. C-111 should be extended east of US1 to allow maximum flexibility and water deliveries to all parts of this system.

Thank you for your time.

Sincerely,

Catherine VerSchneider

Catherine VerSchneider

9560 N. W. 31st Place
Sunrise, FL 33351
April 11, 1994

Mr. Steven Sutterfield
U. S. Army Corps of Engineers
P. O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

I am strongly in favor of re-establishing the historic flow, timing, and distribution of water to Taylor Slough and Florida Bay. Florida Bay is dying because it is starving from the lack of freshwater.

The only living coral reef in the continental U. S. is also being impacted. The quality of life of South Florida is also being destroyed, plus damaging our economy.

I support the Canal 111 Project, Alternative 6A. We must revitalize this crucial resource.

I also support the purchase of the Frog Pond and Rocky Glades agricultural area which is essential to this ecosystem. Farmers should never have been allowed in these areas to begin with!

I also approve of the following improvements to Alternative 6A:

1. The proposed Canal 111N should be designed as a retention/detention area linked to the area to the north.
2. The Corps should use a 500 cfs (cubic feet/second) pump instead of a 50 cfs pump at S-332B.
3. The Corps should expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested in Alternative 8.
4. Canal 111N should be extended east of U. S. Highway 1.

Too much damage has already been done to the Everglades ecosystem. And the taxpayer is still subsidizing the sugar industry to continue polluting the Everglades. Makes no sense. It only angers me.

Sincerely

Carol Weenk

(Mrs. H. Weenk)

cc: Governor L. Chiles

Lawrence Gladsden
10830 SW 84 Street, Apt. G-1
Miami, Florida 33173
305-598-3899

04/08/94

Mr. Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Fl 32232-0019

Dear Mr. Sutterfield,

I support Canal 111 Project, Alternative 6A. The purchase of the Frog Pond and Rocky Glades agricultural areas, and their conversion into a retention/detention area is essential to ensuring water quality and flood control.

The economic analysis for this project would be much more accurate were its effects on the economy of the Florida Keys, and on the various recreational industries associated with a healthier Florida Bay and environs, taken into consideration.

6A, while a good alternative, could be improved if:

* Proposed Canal 111N were designed as a retention/detention area linked to the area to the north.
* A 500cfs pump were used at S-332B.
* The retention/detention area along the west side of L-31N were expanded north to Tamiami Trail as suggested in Alternative 8.
*Canal 111N were extended east of U.S. Highway 1.

I am a life-long resident of Dade County, and an angling enthusiast who loves the Florida Bay area. I would like my children to enjoy it someday, also. Maybe it will be richer for them, instead of poorer -- if we work together to make it that way.

Sincerely Yours,

Lawrence Gladsden

Lawrence Gladsden

North Carolina
Outward Bound School

March 21, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield:

As I will be unable to attend your upcoming hearing on flow restoration into Taylor Slough and Florida Bay through the C-111 projects, I submit the following comments for your consideration.

First of all, I would like to congratulate you, and the Corps, for the thoughtfulness that you obviously put into this research / analysis. With this in mind, I would like to stress:

- I note that you did not include the cost benefit of restoring Florida Bay in your economic analysis. It is crucial that this be a part of such a study as quantifying the benefits of such restoration would substantially add justification for these efforts.

- It is essential that purchase of the Frog Pond and Rocky Glades agricultural area be included in this proposal. These locations are crucial to the future of the Everglades / Florida Bay System.

- I support your choice of alternative 6A, <u>and</u> I would ask that you consider the following:

  -To both ensure flood protection and restoration of sheet flow, the proposed C-111N canal should be designed as a retention / detention area.

  -The Corps should utilize a 500 cfs pump rather than a 50 cfs one at S-332B.

  -To ensure that enough clean water will be made available to both Shark and Taylor Slough, the retention / detention area along the west side of L-31N north to Tamiami Trail should be expanded.

  -C-111N should be extended east of US 1.

Again, thank you for your consideration in this matter. I look forward to learning of the outcome of the upcoming hearing. If there is ever any way that I can be of service or assistance, please do not hesitate to contact me.

Yours,

Doug Wells
Director
Everglades Outward Bound® Center

9423 Fontainebleau Blvd.
Bldg. 37, Unit 104
Miami, Florida 33172
April 12, 1994

Mr. Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Fl 32232-0019

Dear Mr. Sutterfield

We have never met but I know how much you have tried to help clean up the Everglades. I have lived in Florida for over 35 years and have enjoyed camping and wildlife photography in the Everglades for more than 25 years.

As a former science teacher in Dade-County, I took many of my students on field trips to the Everglades and even weekend camping trips. I know how important wetlands are to the health of our nation.

You have my support in the Canal 111 project, alternative 6A, which will restore a good flow of fresh water to Taylor Slough and the eastern panhaldle of the Everglades. In addition, I would suggest the following:

(1) Canal 111 should help restore the historic flow of water through the Everglades, (2) use a 500 cfs pump to help improve the flow of water to the marine environment which helps both the ecosystem and economy of south Florida, (3) expand the area west of L-31N to the Tamiami Trail to provide sufficient water to both Shark and Taylor Slough.

Thank you for helping to restore fresh water to the southern Everglades and for helping promote the good health of the south Florida ecosystem.

Sincerely,

David McCafferty
David Mc Cafferty

16630 S.W. 80th Avenue
Miami, FL 33157

(305) 233-1078 (home)
(305) 378-7499 (work)

April 11, 1994

Mr. Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield:

As a resident of south Florida, I am extremely concerned about the health of the Everglades and Florida Bay, and their impact on the United States' largest coral reef. Therefore, I urge you to support the Canal 111 Project, Alternative 6A.

This Alternative will most effectively address the water quality and environmental crises we are facing. The purchase of the Frog Pond and Rocky Glades agricultural area is essential to the future of the Everglades and Florida Bay.

While Alternative 6A is our best option on the table, it should be improved:

* Proposed Canal 111N should be designed as a retention/detention area linked to the north to provide greater flood protection and restore historic timing and flow.
* A 500 cfs pump should be used instead of a 50 cfs pump at S-332B so waters are pumped into a large retention/detention area along C-111N.
* The retention/detention area along the west side of L-31N north to Tamiami Trail should be expanded as suggested in Alternative 8.
* Canal 111N should be extended east of U.S. Highway 1.

Please act now to give Florida Bay and the Everglades a chance to recover. South Florida's economy is dependent upon tourism. The destruction of these resources is not only an environmental tragedy, it is an economic nightmare.

Sincerely,

Carl R. Hayes
Carl R. Hayes

Cynthia A. Hewitt
Cynthia A. Hewitt

TO: Steven Sutterfield

FROM: Chris L. Kleppin 2750 SW 74th way #2001 Fort Lauderdale, FL 33314

DATE: 4/10/94

RE:

Dear Sir:

It is my wish that you support Alternative 6A for the Canal 111 project, plus some additional modifications. I like the fact that the proposal includes the purchase of the Frog Pond and Rocky Glades agricultural areas, which I think are essential to the future of the Everglades/Florida Bay ecosystem. These areas need to be flooded and put back to their natural state. The proposed retention/detention area, in what is now the Rocky Glades and Frog Pond, is essential to ensuring water quality in this area and for providing flood control for areas east of L-31/C-111 canals.

However, I think the economic analysis for this project is flawed because it does not incorporate the cost of the collapse of Florida Bay versus the benefits of restoring Florida Bay. South Florida's economy is completely dependent upon the environment.

While 6A is a good proposal, it can be improved in the following ways:

The proposed Canal 111N should be designed as a retention/detention area linked to the area to the north to restore the historic timing and distribution of sheet flow in this part of the Everglades.

The Corps should use a 500 cubic feet/second pump instead of a 50 cfs pump at S-332B so that waters are pumped into a large retention/detention area along C-111N. This would allow natural sheetflow to move down through the southern Everglades.

The Corps should expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested in Alternative 8. Only by doing this will the Corps ensure that enough clean water can be made available in historic patterns for both Shark + Taylor Sloughs. Canal 111N should be extended east of U.S. Highway 1.

Sincerely, [signature]

Eli Crays

4/15/94
2116 Discovery Cir W
Pompano Beach - FL
33064

Dear Mr. Sutterfield;

As a resident of Florida may I urge you to extend Canal 111 N. East of U.S. Highway 1 to allow for maximum flexibility; also to use 500 cubic feet (second) pump instead of a 50 cfs pump at S. 332 B, so that water are pumped into a large retention/detention area along C-111 N. I think that expansion of the retention/detention area along the west side of L-31 north to Tamiami Trail would help.

Thank you for your efforts to save the Everglades Florida Bay

Sincerely,

Marcaine C. Churchill

ir. Steven Sutterfield
I.S. Army Corps of Engineers
'.O. Box 4970
Jacksonville, Fl 32232-0019

'ear Mr. Sutterfield:

In regard to the proposed C-111 project for the purpose of restoring water flows into Taylor Slough and Florida Bay in the far southeast region of the Everglades system, we wish to support the project with the following alternative inclusions.

1. Alternative 6-A must include the plugging of C-111.
2. C-111N must be used as a retention area.
3. There must be a larger pump at S-332B.
4. There should be an expansion of the retention area along the west side of L-31N.

This project is critical as this is a key area for providing overland flows into the southeastern area of Everglades National Park and the northeast section of Florida Bay. The natural timing, distribution and water flow to this area has been badly disrupted by the ditching and draining that has occurred in past years.

We hope that you will be enthusiastically behind this plan for recovery.

Most sincerely,

Judith Jens
William Jens

Judith and William Jens
April 6, 1994

Dear Mr. Sutterfield:

I am writing this letter in support of the Canal 111 Project, Alternative 6A. This project is crucial to the restoration of Florida Bay as well as the economy and quality of life in South Florida.

As a South Floridian I support all efforts to save our precious wetlands, however Alternative 6A can be improved in a number of ways.

1. Canal 111N should be extended east of U.S. Highway 1.
2. The Corps should use a 500 cfs pump instead of a 50 cfs pump at S-332B.
3. The proposed Canal 111N should be designed as a retention/detention area linked to the area to the north.
4. The Corps should expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested in Alternative 8.

Please protect our delicate ecosystems by saving the wonderful plants and animals that live in them.

Sincerely,

Karen Witusik

Karen Witusik
5507 Grant Street
Hollywood, FL 33021

April 15, 1994

Mr. Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Fl 32232-0019

Dear Mr. Sutterfield:

We are writing so that the Corps and especially those of you charged with proposed C-111 Project will be aware of our views during your decision making regarding this absolutely ecologically critical project. We are strongly in favor of this restoration project!

Everglades National Park and Florida Bay are dependent on the overland flow of fresh water provided by this key area. We highly value the natural wealth of these treasures of Florida and are most concerned for both the endangered species in them and the economic well-being of the fishing and diving industries in the Keys. The restoration proposed is essential to the ecological integrity of Taylor Slough and the eastern area of the Everglades.

We want you to know that we feel the economic analysis for this project is deficient - The benefits of economy recovery to the fishing and diving industries in the Florida Keys/Bay should be quantified because they will add significant additional economic justification for restoring previous ecological health.

Also, please consider that by providing drainage benefits not provided by law to the farmers in the Frog Pond area, the Corps and the District have hurt the Park and Florida Bay because these actions also drain Taylor Slough's adjacent marshes. Therefore, the purchase of the Frog Pond and Rocky Glades agricultural area contemplated by this proposal is completely necessary to the future of the Everglades and Florida Bay system.

The proposed retention/detention areas in the Rocky Glades and Frog Pond are essential for flood control east of L-31/C111 canals and for water quality.

Lastly, please consider improving Alternative 6A, which we feel is a good approach, but needs improvement in the following ways:

1. The proposed C-111N canal should be designed as a retention/detention area linked to the area to the north. This is for flood control and natural timing and coverage of sheetflow.
2. The Corps should use a 500 cfs pump, not a 50 cfs one at S-332B so that natural sheetflow moves down through the southern Everglades.
3. Ensure enough clean water in historic patterns for both Shark and Taylor Sloughs by expanding the retention/detention area along the west side of L-31N north to the Tamiami Trail as suggested by Alternative 8.
4. Extend C-111N east of US1 for greatest flows and flexibility throughout this system.

Thank you for considering our values, hopes, concerns and views, we feel so strongly about the value of our environment,

Sincerely,

Walter Foy
[signature]

Jane Rogers & Walter Foy
2011 Alameda Dr.
Deltona, FL
32738

Matt Berres
9120 Joy Rd
Plymouth, MI.
48170

Mr. Steven Sutterfield
U.S. Army corps of Engineers
P.O. Box 4970
Jacksonville, Fl 32232-0019

Mr. Sutterfield,

I am writing you to express my concern regarding Project C-111 and its effects on the Taylor Slough and Florida Bay. As you know the C-111 canal, located in the far southeast region go the Everglades system, is a key area for providing overland water flows into the southeastern portion of Everglades National Park and the northeast area of Florida Bay. This area provides important habitat for many endangered species such as the Wood Stork, Cape Sable Sparrow, American Crocodile and the Snail Kite. I am sure you are also aware that water management practices in this area have allowed the Everglades to be over-drained and prevented water from going into Florida Bay. This over drainage has caused significant ecological harm to the Everglades/Florida Bay area.

I understand that through your reviewing process have found Alternative 6A to provide an equal amount of flood protection as the tomato farmer's Alternative 9, as well as providing the greatest benefit to the environment, greater operational flexibility and flood damage prevention capability to agriculture.

However, I encourage you to consider the following improvements to Alternative 6A in order to maximizes its effectiveness:

- The proposed C-111N canal should be designed as a retention/detention area linked to the area to the north, to more fully ensure flood protection to communities to the north, and to restore the historic timing and distribution of sheet flow in this part of the Everglades.
- The Corps should use a 500 cfs (cubic feet/second) pump instead of a 50 cfs pump at S-332B so that waters are pumped into a large retention/detention area along C-111N. This would allow natural sheet flow to move down through the southern Everglades area into the marine environment, providing ecological benefits while allowing for greater flood protection.
- Expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested in Alternative 8. Only by doing this will the corps ensure that enough clean water can be made available in historic patterns for both Shark and Taylor Sloughs.
- C-111N should be extended east of U.S. Highway 1 to allow for maximum flexibility and water deliveries to all parts of this system.

I urge you to consider these recommendations when deciding on Alternative 6A. They will make Alternative 6A even better for the Everglades and Florida Bay ecosystem.

Sincerely,

Matt Berres
A concerned citizen

Lawrence Gladsden
10830 SW 84 Street, Apt. G-1
Miami, Florida 33173
305-598-3899

04/08/94

Mr. Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Fl 32232-0019

Dear Mr. Sutterfield,

I support Canal 111 Project, Alternative 6A. The purchase of the Frog Pond and Rocky Glades agricultural areas, and their conversion into a retention/detention area is essential to ensuring water quality and flood control.

The economic analysis for this project would be much more accurate were its effects on the economy of the Florida Keys, and on the various recreational industries associated with a healthier Florida Bay and environs, taken into consideration.

6A, while a good alternative, could be improved if:

* Proposed Canal 111N were designed as a retention/detention area linked to the area to the north.
* A 500cfs pump were used at S-332B.
* The retention/detention area along the west side of L-31N were expanded north to Tamiami Trail as suggested in Alternative 8.
*Canal 111N were extended east of U.S. Highway 1.

I am a life-long resident of Dade County, and an angling enthusiast who loves the Florida Bay area. I would like my children to enjoy it someday, also. Maybe it will be richer for them, instead of poorer -- if we work together to make it that way.

Sincerely Yours,

Lawrence Gladsden

Lawrence Gladsden
10830 SW 84 Street, Apt. G-1
Miami, Florida 33173
305-598-3899

28 Avalon Street
Clearwater FL 34630
April 13, 1994

Steven Suttenfield
U.S. Army Corps of Engineers
P O Box 4970
Jacksonville FL 32232-0019

Dear Mr. Suttenfield,

I am writing to you because of my concern about the declining "health" of the Everglades.

I urge you to consider the following points when selecting a plan to restore flows into Taylor Slough and Florida Bay through the proposed C111 Project.

You are considering several alternatives with a preference for Alternative 1-6A ...

The economic analysis for this project is flawed because it does not include the cost of the collapse of Florida Bay vs the benefit of restoring it. Because of the degradation of Florida Bay the economy of the entire Florida Keys is endangered. Fresh water flow is essential to Florida Bay restoration -- and thereby, to the economic recovery of the area, which should add additional economic justification for restoring historic conditions.

Purchase of the Frog Pond and Rocky Glades agriculture area contemplated by the proposal is essential to the future of the Everglades/Florida Bay systems.

The proposed retention/detention area in what is now Frog Pond and Rocky Glades is essential to ensuring water quality in this area as well as providing flood control for areas east of L-31/C111 CANALS.

While Alternate 6A is a good one it can be improved by:

- designating C111N Canal as a retention/detention area linked to the area to the north, to more fully ensure flood protection to communities to the north as well as restore historic timing and distribution of sheetflow in that part of the Everglades -
- using a 500 cfs pump instead of a 50 cfs one at S-332B to allow natural sheetflow to move through southern Everglades into the marine environment. This also provides ecological benefits while allowing for greater flood protection.
- expanding the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested in Alternative 8. Only by doing this will the Corps ensure that enough clean water can be made available in historic patterns for both Shark Slough and Taylor Slough.
- extending C111 east of U.S. 1 to allow maximum flexibility and water deliveries to all parts of this system.

Thank you for your time and attention.

Sincerely,

Marjorie B. Herndon

MARJORIE B. HERNDON

SIERRA CLUB

Loxahatchee Group

Palm Beach County

April 10, 1994

Mr. Steven Sutterfield
US Army Corps of Engineers
PO Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield:

The Sierra Club Loxahatchee Group, representing over 1400 members in Palm Beach County, urges you to **adopt C-111 Alternative 6A** in your attempt to restore water flow to the Taylor Slough and eastern Everglades.

Landowners in the Frog Pond and Rocky Glades areas have successfully lobbied the government over the last decade to give them more and more drainage benefits which are not provided by law. The present canal system has been devastating to the Everglades National Park and the Florida Bay, and must be changed before it is too late.

We believe that Alternative 6A is a good compromise, providing adequate flood protection for agricultural interests while also providing the freshwater necessary to help the Everglades and the Florida Bay. But this alternative can be improved.

Please consider designing the proposed **C-111N canal as a retention/detention area** linked to the area to the north. This would provide better flood protection to communities to the north and also would restore historic timing and distribution of sheetflow in this part of the Everglades. Also, please consider using **a 500 cfs pump** instead of the proposed 50 cfs pump at S-332B so that waters are pumped into the retention/detention area along C-111N.

While economic considerations are important, they should be balanced with environmental and human health considerations. In the past, canal projects were undertaken based solely on economics and Florida has suffered, and will continue to suffer for many years, due to these decisions. Please do not allow the Everglades/Florida Bay ecosystem to continue to die.

Sincerely,

Roberta Gastmeyer

Roberta Gastmeyer
Conservation Vice Chair

MR SUTTERFIELD

THIS LETTER IS IN REGARDS TO CORPS PLAN 6A FOR THE C-111 CANAL. PLEASE CONSIDER BACKFILLING THE MANATEE BAY END OF THE CANAL TO STOP ALL DISCHARGE OF FRESH WATER INTO MANATEE BAY! ALSO TO SAVE THE FLA. BAY WE MUST PURCHASE FARMING AREAS ROCKY GLADES AND FROG POND TO RESTORE FRESH WATER FLOWS TO SHARK RIVER AND TAYLOR SLOUGHS. PLEASE CONSIDER AMENDING THE PROPOSED C-111N SPREADER CANAL WITH A WATER RETENTION/DETENTION AREA NORTH OF THE TAMIAMI TRAIL.

THANKS FOR YOUR TIME

SINCERELY

John Whalton
PO BOX 501416
MARATHON FL
33050-1416

April 6, 1994

Mr. Steven Sutterfield
US Army Corp of Engineers
P. O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

I am writing to inform you that I am in favor of **CANAL 111 Project plus Alternative 6A**, with the following changes:

- Proposed Canal 111 N should be designed as a retention/detention area linked to the area to the north, and
- The Corp should use a 500 cfs (cubic feet/second) pump instead of a 50 cfs pump at S-332-B, and
- The Corp should expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested in Alternative 8, and
- Canal 111 N should be extended east of US Highway 1.

Please add my voice to the many other voices for the Everglades/Florida Bay.

Sincerely,

Therese M. Richeal

Therese M. Richeal
3421 Andover Drive
Fairfax, Virginia 22030

APPRAISALS & ESTATE SALES
Lucie Anderson • 1122 Circle Drive • Lake Wales, FL 33853 • (813) 676-8660

March 28, 1994

Mr. Steven Sutterfield
U.S. Army Corp of Engineers
P.O. Box 4970
Jacksonville, Fl 32232-0019

Dear Sir,

In regard to the C-111 Project, I feel that Alternative 6A is good but can be improved as follows:

a) The proposed-111N canal should be designed as a retention/detention area linked to the area to the north.
b) C-111N should be extended east of U.S1 to allow maximum flexibility and water delivery to all parts of the system.
c) Expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested by Alternative 8.
d) Using a 500 cfs pump provides eco. logical benefits while allowing greater flood protection as well.

Respectfully submitted,
Lucie P. Anderson,
Ridge Audubon Socy.

U. Votership: City I, Precinct-19; Cong-12; Sen-17
Hse-65

7200 S.W. 6 ST
MIAMI, FL 33144
MARCH 31, 1994

Mr. Stephen Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Fl 32232-0019

Dear Sir:

I am a resident of Dade County since 1936, a homeowner and concerned citizen. I attended the March 29 meeting at Homestead on the proposed C-111 Project but did not air my views, which are:

1. The alternative 6A proposal is the best solution to restoring adequate water flow, including purchase of Frog Pond and Rocky Glades land.

2. A new retention area should be created to replace C-111N south of Homestead and Florida City and the C111N filled south of this retention area. The new retention/detention area should extend east of U.S. 1.

3. Use a 500 cfs pump at S-332E.

4. Expand the retention/detention area north to Tamiami Trail along west L31N.

Yours truly

April 6, 1994
403 Oakwood Ct
Fern Park, FL 32730

Mr. Steven Sutterfield
US Army Corps of Engineers
PO Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

Florida Bay is in desperate need of fresh water. The health of the marine life is suffering and the tourist trade will be suffering because of it. This deterioration can be reversed by restoring the historic sheet flows of water in the C-111 area and I am writing to urge you take the actions which will accomplish this.

If Florida Bay collapses, we will have a situation similar to what happened in the area around Lake Apopka. I'm sure you are aware of what happened to this once beautiful and economically thriving fishing community. The economy of the Florida Keys is based in large part on fishing and diving. The sensible way to restore the quality of water in the bay is to allow its full range of cleansing flow.

Additionally, a larger pump should be used at S-332B so that more water is pumped into the retention area along C-111N. This will provide for even greater ecological benefits and allow for flood protection as well.

Yours truly,

Samuel Kendall

Samuel Kendall

Adam Redford
18611 SW 92nd Ave.
Miami, FL 33157

Mr Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Fl 32232-0019

April 13, 1994

Dear Mr. Sutterfield:

I am a registered voter residing in Dade County who enjoys fishing and diving in the Everglades and the Florida Keys. I would like to state my support for the Canal 111 Project, Alternative 6A.

The Frog Pond and Rocky Glades areas should be purchased from the current owners and used as retention/detention area.

THe proposed Canal 111N should be designed as a retention/detention area linked to the area to the north.

The Corps should install a 500cfs pump instead of a 50 cfs pump at S-332B to pump water into C111N to restore sheetflow.

As suggested in Alternative 8, the retention/detention area along the west side of L-31N north to Tamiami Trail should be expanded.

I, like many others, feel that it is imperative that rapid, effective action be taken to restore this unique ecosystem which is vital to the economic health of Monroe County, and is enjoyed by visitors from this State, this country and the rest of the world.

Sincerely yours;
Adam Redford
Adam Redford

March 30, 1994

United States Army Corps of Engineers
Post Office Box 4970
Jacksonville, Florida 32203

Dear Sirs:

Thank you for the opportunity to comment on proposed solutions for the serious problems involving Florida Bay. I attended the hearing on Tuesday, April 29, 1994, at Homestead High School, and I request that this letter be placed on record.

I am a permanent year-round resident of Islamorada. I am employed by a local resort, and I scuba dive, snorkle, and sail.

I emphatically support immediate implementation of Alternative 6A, along with the provisions of the Audubon Society and the purchase of the entire Frog Pond and Rocky Glades areas.

I request the immediate filling of the C-111 canal, as well as the extension of detention/retention basins.

I ask that the measures necessary to restore Florida Bay and to reestablish sheet flow be taken regardless of effect upon residential, business, or recreational concerns in either the Keys or the mainland.

My position is based upon the fact that, although we can not fully restore the Everglades and Florida Bay to their natural state, we can take responsibility for preventing further degradation.

It is imperative that evaluations of these issues consider the full impact of the massive degradation of one of our nation's few remaining wilderness areas and one of the world's few living coral reefs. We choose to live in a delicate area, and we have not been good stewards. We--both islanders and mainlanders--now reap the consequences.

Again, please accept my appreciation for your time and interest.

Respectfully,
Cheryl W. King
Cheryl W. King

Post Office Box 2095
Key Largo, Florida 33037

Sanibel-Captiva Audubon Society
P.O. Box 957
Sanibel Island, Florida 33957

March 31, 1994

Mr. Steven Sutterfield
Army Corps of Engineers
P.O.Box 4970
Jacksonville, FL 32232-0019

Re: Everglades Restoration

Dear Mr. Sutterfield

C-111, in the southeastern corner of the Everglades, provides flow to Everglades National Park, and the northeast corner of Florida Bay, areas vital to recovery of habitat for several endangered species, including the snail kite, woodstork, Cape Sable sparrow and American crocodile.

To this end, the Sanibel-Captiva Audubon Society urges the Corps of Engineers to act promptly to restore flow into Taylor Slough and Florida Bay through the proposed C-111 Project.

You have several alternatives, and prefer 6A. We feel 6A can be improved, and urge you to consider the following modifications.

Expand the proposed retention/detention area in the Rocky Glades-Frog Pond area to ensure water quality and provide flood control for areas east of the L-31/C-111 canals.

The C-111N canal should be designed as a retention/detention area to ensure flood protection for areas to the north.

A 500 cfs pump is essential to provide enough water for sheet flow through the southern Everglades area .

The retention/detention area along the west side of L-31N to the Tamiami Trail should be expanded to ensure enough water for both Shark Slough and Taylor Slough.

We appreciate your concern, and look for quick action.

Sincerely,

Bob Slayton
Bob Slayton
Conservation Chair

LLOYD BRUMFIELD
11225 S.W. Meadowlark Circle
Stuart, Florida 34997
(407) 286-4326

April 4, 1994

Mr. Steven Sutterfield
U. S. Army Corps of Engineers
P. O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield:

Subject: Restoring Flows Into Taylor Slough and Florida Bay Through The Proposed C-111 Project Recommending Alternative 6A With Certain Modifications

As a matter of background, I lived in Dade County for 28 years and have detail knowledge of the Redlands Area, Florida Bay and the Florida Keys, Everglades waterflow, sugar cane and all other farming, people-urban development, etc. etc. etc. Also, I have been involved in the South Florida Water Management District's activities concerning the Everglades and Florida Bay. I was in attendance at the Corp's hearing here in Palm City last December 6 and wrote a document for the Corp.

It is my recommendation that Alternative 6A be adopted, however, several changes need to be made in 6A.

(1) Canal C-111 should be plugged to prevent sea grass from dying. (2) C-111N should be a retention area for sheetflow. (3) Larger pumps should be used along C-111N. (4) Expand the retention area along the west side of L-31N to Tamiami Trail. (5) C-111N should be extended east of US 1.

Respectfully submitted,

L. Brumfield
Lloyd Brumfield

CATBIRD LANDING

POST OFFICE BOX 760
CAPTIVA ISLAND, FLORIDA 33924

April 6, 1994

Mr. Steven Sutterfield
US Army Corps of Engineers
P.O.Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield:

We are writing with regard to the proposed C-111 project ~~to~~ re-store flows into Taylor Slough and Florida Bay in the far southeast re-gion of the Everglades system.

As you know, this is the key area for providing overland flows into the southeastern part of Everglades National Park and the north-east corner of Florida Bay. It is the ditching and draining of this area that has disrupted the natural timing, distribution and flow of water to this area.

We support alternative 6-A in the C-111 project PROVIDED THAT this alternative also includes the plugging of C-111, the use of C-111N as a retention area, a much larger pump at S-332B, and an expansion of the retention area along the west side of L-31N, as the best alternative available for the restoration of Florida Bay.

I hope you agree with and will push this plan.

Sincerely,

Laura and Bill Riley

Laura and William Riley

Mar 23, 1994

Mr. Sutterfield

The Audubon Society suggested I write comments on the Everglades/Florida Bay proposed Project C-111.

I understand the project analysis does not include the cost of the collapse of Florida Bay vs. the benefits of restoring it. It should be included.

I believe purchase of the Frog Pond and Rocky Glades agricultural area is essential to the future of the Everglades / Florida Bay system.

The proposed retention/detention area (now Rocky Glades and Frog Pond) is needed to insure water quality, and provide flood control for areas east of L-31/C-111 canals.

To more fully ensure flood protection to communities to the north, as well as restore historic timing and distribution of sheetflow in this part of the Everglades, C-111N canal should be a retention/detention area linked to the area to the north.

Expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested by alternative 8.

C-111N should be extended east of US 1 to allow maximum flexibility and water deliveries to all parts of the system.

Install a 500 cfs pump instead of a 50 cfs one at S-332 so that water is pumped into a large retention/detention area along C-111 allowing natural sheetflow thru the Southern Everglades providing ecological benefits as well as greater flood protection.

Sincerely,

[illegible]

April 8, 1994

Steven Sutterfield
U.S. Corps of Engineers
P.O. Box 4970
Jacksonville, FL

Dear Sir,

I endorse alternative 6A to increase the flexibility of the C-111 system to restore the natural water levels. Florida Bay is a disaster area — fresh water flow is absolutely essential to restoration of the Bay.

The proposed retention/detention area will ensure water quality & provide flood control, but consid the expansion of the area along the west side of L-31N north to Tamiami Trail, as suggested by Alternative 8 be added. It would ensure the availability of clean water for both Shark Slough and Taylor Slough.

Sincerely
Johny Zadek
5400 N. Travelers Palm Lane
Tamarac, FL 33319

April 8, 1994

Mr. Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232

Dear Mr. Sutterfield:

I support the Canal 111 Project, Alternative 6A to benefit the ecology of the southeastern Everglades.

I suggest the following improvements to Alternative 6A and ask that they be considered.

The proposed Canal 111N should be designed as a retention/detention area linked to the area to the north so that there would be more flood protection to communities to the north and to restore the historic timing and distribution of sheet flow in this part of the Everglades.

The Corps should use a 500 cfs pump instead of a 50 cfs pump at S-332b to provide for better ecological benefits while allowing for greater flood protection.

The Corps should expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested in Alternative 8 to ensure that enough clean water can be made available in historic patterns for both Shark and Taylor Sloughs.

Canal 111N should be extended east of U.S. Highway 1 to allow for maximum flexibility and water delivery to all parts of the system.

Thank you for consideration of this vital help for the Everglades and Florida Bay. As a retired teacher of gifted elementary children in Broward County that have studied and appreciated the value of the Everglades, and taken fields trips to observe this valuable area of our state, I urge you on behalf of the youth of our state to support these restoration projects.

Elizabeth Schrader

(Mrs.) Elizabeth Schrader
1557 NW 97th Terrace
Coral Springs, FL 33071

Mr. Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville FL 32232

RE: Everglades System

Dear Mr. Sutterfield:

Alternative 6A is a good choice, but would be improved by:

1) by increasing [illegible] of S-336 to 500 cfs
2) expanding retention/detention area along west side of L-31N to Tamiami Trail
3) extend C-111 [illegible] of US 1

Thank you for considering these suggestions

Sincerely
Michael A. [illegible]
16102 E Lake Burrell Dr
Lutz FL 33549

March 30 1994

Mr. Steven Sutterfield
US Corp of Engineers
P.O. Box 4970
Jacksonville FL 32232-0019

Dear Mr Sutterfield

I attended the Meeting of farmers + fishermen March [illegible] 1994 in Homestead. While I understand the concern of the farmers and we all do need food, I wonder why they are where they are in the first place - why were they ever allowed to drain the Everglades. Developers are still draining, filling in and building Shopping Centers that are Not needed. This needs to be changed.

I love the Everglades and have spent many happy hours there. I believe proposal #6A will help a lot but should be modified as per Audubon recommendations.

[illegible] E. James
[illegible] SW [illegible] St
Miami FL 33156
305 595 [illegible]
Voter [illegible] 0035683

AUDUBON SOCIETY
OF THE EVERGLADES
P. O. BOX 6762, WEST PALM BEACH, FLORIDA 33405 PHONE (305) 588-6908

MARCH 31, 1994
RE: CANAL-111 PROJECT

MR. STEVEN SUTTERFIELD
JAX DIST., ARMY CORPS OF ENGINEERS
DEAR SIR,
AFTER CAREFUL CONSIDERATION THIS AUDUBON CHAPTER URGES YOU TO ADOPT AND A.S.A.P. IMPLEMENT OPTION 6A TO INCREASE THE FLEXIBILITY OF THE C111 SYSTEM TO HELP RESTORE PROPER FLOWS TO THE EVERGLADES NATIONAL PARK.
WE URGE MODIFYING THIS PLAN TO INCLUDE A 500 CFS PUMP AT S332B, EXPAND RETENTION/DET. AREA ON C-111N, (and L31N) AND ALSO TO PROTECT BARNES SOUND & MANATEE BAY BY PLUGGING C111.

SINCERELY,
Chuck Potter
V. PRES., A.S.E
(407) 586 4221

3/30/94

Dear Mr. Sutterfield-
I have been following media coverage on the condition of Florida Bay. As a citizen of the state, I hope you will do all that is necessary to restore the water flow into Taylor Slough and Florida Bay. I do not have the scientific or technical knowledge to intelligently form an opinion. So I depend on the Audubon Society and the Sierra Club to keep me informed. I trust their scientific and technical knowledge and therefore follow their recommendations. Per their suggestion, I am asking you to stick with Alternative 6A. Any other action seems not to be in the interest of this state's future, but rather for the interest of special interest groups with short-term profits in mind. The loss of Florida Bay will be devastating to the state's economy, especially income from the fishing and diving industries... tourism too. And of course the Bay + the entire remaining Everglades are too precious to our environment to be further degraded. I implore you to consider the improvements to Alternative 6A that the Audubon Society is presenting to you and to the corps. Thank you for your time and attention.
Sincerely,
Gail Larkin
6879 Bridlewood Ct.
Boca Raton, FL

The Nature Conservancy.
a Chapter

FAXED

April 18, 1994

Mr. Stephen Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232

VIA FAX: 904-232-3442

RE: C-111 - Draft Integrated General Reevaluation Report and Environmental Impact Statement.

Dear Mr. Sutterfield:

I am writing you to provide The Nature Conservancy's comments on the GRR for the C-111 canal.

The C-111 canal system effectively controls water levels and flows in the ecologically important Taylor Slough watershed. Therefore, the structure and operation of this canal system have an enormous impact on the health of Everglades National Park and Florida Bay.

Florida Bay is a critical economic resource for Monroe County as well as environmental resource. A vast segment of the county's $2 billion annual tourist economy and $90± million annual commercial fishing economy depend upon the ecological health of Florida Bay. In addition, real estate business and tax revenues in Monroe County depend upon environmental health, which is what draws people to the Keys.

Florida Bay is undergoing an ecological collapse. At least 83,000 acres of seagrasses which are food and shelter for fish and shellfish have died. Millions of sponges have been killed, eliminating habitat for commercially-valuable spiny lobsters. Algae blooms and resuspended sediments, unleashed by the seagrass die-off, have clouded the Bay's clear waters and have intruded over the coral reefs, compounding the damage and affecting fishing and diving activities.

There is scientific consensus that the restoration of clean, fresh water flows to Florida Bay is an action that can be taken now to restore Florida Bay. These flows have been systematically reduced by as much as 80% over the last fifty years as the result of the Corps' construction and management of the canal system in South Florida. As a result of these past actions, Florida Bay has been changed from an estuary into a hypersaline lagoon.

Lee Road Suite 500 • Winter Park FL 32789 • 407 628-5887 • FAX 407 644-1778

The restoration of Florida Bay must be a paramount objective for the Corps in their management of fresh water and the canal system on the mainland. The environmental health of Florida Bay and the coral reefs depends on it as well as Monroe County's economy.

The C-111 canal system is a critical part of the canal system that now controls flows to Florida Bay. The C-111 canal system has been used to divert fresh water away from Taylor Slough where it used to contribute to the Bay's freshwater flows. The Corps has taken this action without considering the harm to downstream resources in Florida Bay and the Florida Keys. In turn, the adverse impacts to downstream economic interests in the Florida Keys have also not been considered. This policy and action must be reversed.

In addition, the C-111 has been used to release huge quantities of fresh water into Manatee Bay during high rainfall years. These unnatural slugs of fresh water have resulted in fish kills and damages to the marine resources of the Florida Keys. Again, these actions have been taken to the detriment of the people of Monroe County.

New plans for the C-111 canal system must reflect the full range of values that are affected: Florida Bay, and the environment and economy of Monroe County - not just interests in South Dade County. The new plans must advance the restoration of fresh water flows to Florida Bay, eliminate the harmful discharges to Manatee Bay, and must be formulated to account for their impacts to the economy of Monroe County.

The Nature Conservancy asks you to consider the following specific comments on the Corps' preferred alternative for reconstruction of the C-111 canal system:

1. The environmental and economic impacts of the plan on Monroe County have been completely left out of the analysis. This is a serious shortcoming in the Corps planning. The Corps actions regarding the C-111 canal have seriously impacted the economy of Monroe County, and the plan is incomplete without this analysis.

2. The preferred alternative, plan 6A, is a step in the right direction, but it does not go far enough in satisfying the preceding concerns and objectives. The analyses and computer models from Everglades National Park, as well as from the Corps itself, indicate that the preferred plan will make modest advances in restoring fresh water levels in Taylor Slough, and thus fresh water inputs to Florida Bay.

3. The Nature Conservancy supports the following specific parts of Plan 6A:

- Acquisition of the lands west of the L-31/C-111 canals known as the Frog Pond and the Rocky Glades Agricultural Area. Keeping these lands dry enough to farm causes huge losses of fresh water to Taylor Slough and Florida Bay, damaging the environment and the economy of Monroe County.

- Establishment of the retention/detention areas west of the L-31, with pumps and structures to deliver water westward into Taylor Slough.

- Backfilling of the C-109 and C-110 canals, with 9-10 plugs in each.

- Building a 1,000 foot bridge across State Road 9336 (the road to Flamingo) at the Taylor Slough crossing, to replace the current inadequate bridge and culverts.

These structural and land-use changes will benefit Florida Bay by increasing water levels and flows in Taylor Slough, and increasing fresh water flows to Florida Bay.

4. The Nature Conservancy requests that the following changes be made in the preferred plan 6A:

- Replace the proposed C-111N spreader canal with a water detention/retention area running east-west at the head of the C-111 basin. The detention/retention area must be located further north that the proposed spreader canal, in order to re-established fresh water flows and deliver maximum benefits to these coastal wetlands. The retention/detention area must extend across US-1 in order to re-establish fresh water flows into the impounded wetlands between US-1 and Card Sound Road. Construct a 500 cfs pump at the S-332B location to accommodate high rainfall periods as well as normal years.

- Plug and backfill the existing C-111 canal below the S-18C structure, eliminate the S-197 structure. The C-111 canal must *never again* be used to discharge flood waters to Manatee Bay. Construction of the retention/detention area described above, and the larger pump, will give operational flexibility to manage high rainfall periods.

recycled paper

- In the long-term, the retention/detention area west of the L-31 canal & levee must be extended northward to Tamiami Trail. The productivity and health of Florida Bay will be restored only if more fresh water is delivered to Taylor Slough from Water Conservation Area 3, and fresh water levels and flows are restored in both Taylor and Shark River Sloughs.

These changes to the preferred plan will help to eliminate the adverse impacts that Florida Bay and the Florida Keys have suffered as a result of past activities in the C-111 basin.

Finally, The Nature Conservancy requests that the Army Corps of Engineers accelerate the schedule for the preferred plan. The crisis in Florida Bay is too urgent, a compressed schedule must be implemented. The Corps must request funds from Congress in Fiscal Year 1995 to begin implementation of the preferred plan, with the modifications listed above.

Thank you for the opportunity to comment on the C-111 GRR. Please do not hesitate to contact me if you have any questions.

Sincerely,

John Flicker

John Flicker
State Director

recycled paper

F. L. SIMON, JR.
Apt. 311 - The SHORE
5757 Gulf of Mexico Dr.
Longboat Key, FL 34228

March 26, 1994

Mr. Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield:

Re: The Proposed C-111 Project

I am in full support of this project since the restoration of Florida Bay is so important to the Everglades, area water quality, flood control and the economy of the Keys. I also feel that alternative 6A can be improved by expanding the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested by Alternative 8 to restore the historic patterns of clean water in Shark and Taylor Sloughs.

Maybe with this project the Corps of Engineers will get its good name back again.

Sincerely,

F. Lester Simon, Jr.

FLS/e

Mr. Steven Sutterfield.
US Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

March 25, 1994.

Dear Mr. Sutterfield,

While I can not attend the Public Hearing in Homestead on March 29th, I am pleased to have the opportunity to comment in favor of one of the alternatives # 1 - 6A.

What could be better than releasing fresh water to the Everglades and Florida Bay without flooding the farmers?!! However, creating a retention area in a proposed canal, C-111N, is suggested to enhance beneficial sheet flow distribution, and extending the canal east of US 1 would provide greater flexibility.

I support your efforts to halt overdraining, and to take measures as above to remedy the present situation.

Virginia J. Cochran

213 Ninth Ave. S.
[illegible]

March 30, 1994

Colonel Salt
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Colonel Sir:

My wife and I live on Florida Bay and are appalled and sickened by the environmental collapse we see going on around us. The lack of fresh water into Florida Bay has caused hyper-salinity, dead smelly sea grasses, which caused algae blooms covering 100's of square miles, which has killed all sponges in a 400-600 square mile area, which has caused an 80% drop in pink shrimp and a 30% drop in juvenile lobster.

Thirty percent of the bay is already unfishable, and we've stopped boating our friends from up north to Flamingo, because instead of being a positive environmental experience, it has become depressing. I'll never forget the look on the face of my fishing buddy from Seattle when we entered "The Dead Zone".

The pea soup has already begun to destroy this country's only living coral reef. Remember, once it's dead, it's not coming back. Is that what you want on your tombstone? "I killed the Everglades, Florida Bay, and America's only coral reef".

I spent eight hours travelling and attending yesterday's public hearing on the Corps of Engineer's plan for the C-111 canal. Your plan is good, but WE CANNOT WAIT ANOTHER TWO YEARS TO START WORK!!! THERE WON'T BE ANYTHING LEFT TO SAVE!!! There was no explanation at the hearing for the delay.

Please act now:
1. Put plan 6A into effect immediately.
2. Purchase Rocky Glades and the Frog Pond using eminent domain via Senate bill 2770. Push for U.S. Senate Bill S1631 which identifies money to pay for this land.
3. The Corps should use a 500 CFS pump instead of a 50 CFS one at S-332E to reestablish natural sheet flow, rather than flushing stormwater down C-111 killing marine life in Barnes Sound and Manatee Bay.
4. Fill the end of the C-111 canal, steering fresh water to Taylor Slough rather than into the Atlantic.

I apologize for the terse tone of this letter. I know the wheels of government turn slowly, but you must make an exception and take bold action. You look like a fine military man. Please act like one.

We are waiting, Mother Nature is not.

OKLAWAHA VALLEY AUDUBON SOCIETY, INC.

Post Office Box 641
Eustis, FL 32727-0641
March 29, 1994

Mr. Steven Sutterfield
U. S. Army Corps of Engineers
P. O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield:

We regret that we are not able to attend the hearing today on the restoration of flows into Taylor Slough and Florida Bay through the proposed C-111 Project.

We are deeply concerned with the need to restore overland flows in the area and improve the ecology of the southeastern Everglades and Florida Bay. Such restoration is long overdue.

Alternative 6A chosen by the Corps appears to fill the need for most of this restoration, however we have several suggestions which we hope you will take under consideration.

1) Designate the proposed C-111N canal a retention/detention area linked to the area to the north.

2) Increase the pumping capacity at S-332B from 50 cfs to 500 cfs to insure a natural sheetflow through the southern everglades from the retention/detention area as well as providing greater flood protection.

3) Expand the retention/detention area along the west side of L-31N north to Tamiami Trail, thus insuring enough clean water can be made available for both Shark Slough and Taylor Slough.

4) Extend C-111N east of US1 to allow maximum flexibility and water deliveries to all parts of this system.

Thank you for your commitment to "saving" the east Everglades and Florida Bay. We realize that you will have some stiff opposition from the agricultural interests, but rely on your good judgment and knowledge of the current situation to insist on the best alternative, modified if necessary.

Very truly yours

Linda Kissner

Linda Kissner, President

LK:YR

MR & MRS RICHARD H SCHROO[illegible] [illegible] COCOA BEACH FL [illegible]

4/1/94

Mr Steven Sutterfield
USA Corps of Engineers

Dear Mr Sutterfield:

The restoration of the Everglades and Florida Bay is very important to our country and the environment. The benefits of restoring FL Bay are immense. The personal interests of a few farmers are of far less importance.

Alternative 6A appears, with perhaps some modest enhancements suggested by Audubon seems reasonable. Let's stop talking and get down to restoring the Everglades now. We've wasted too many years doing little more than talk.

Thank you.

Sincerely,

M/M R.H. Schroo[illegible]

3-31-94

Dear Mr. Sutterfield,

I urge you to take quick action to restore fresh water to Florida Bay. I'm glad you are acting on Alternative 6A, but surely a retention/detention area could be established real soon. The bay needs fresh water NOW!

Thank you,

Alice K. Badenell

8513 SW 147 PL

Miami, FL 33193

14910 S.W. 74 Avenue
Miami FL 33158-2121

March 29, 1994

Mr. Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville FL 32232-0019

Dear Mr Sutterfield:

The task facing the Corps in the C-111 project is formidable, but must be completed if Florida Bay and the Florida Keys are to have any future at all.

When farmers say this project is jeopardizing their future, they ignore the simple fact that the existing system which has expanded their drainage benefits above and beyond what the law allows is killing another natural resource, every bit as precious as our agriculture industry. Over the past 10 years, agricultural interests have successfully twisted the government's arm in draining Frog Pond and the adjacent marshes in Taylor Slough. The result of this drainage is clearly visible in Florida Bay.

While farmers complain that their way of life will be endangered if these generous drainage benefits are reduced, they must remember that another group has already suffered at their expense. Fishermen, charter boat operators, and residents depend on Florida Bay for their livelihood, and watch their way of life disappear everyday. As one third-generation Key's resident said, "Florida Bay is our field--fishing and tourism are our crops."

To sum up, the economic benefits of a healthy Florida Bay and a sustained tourism industry in the Florida Keys should be taken into account whenever a cost/benefit analysis of the C-111 project is mentioned. The proposed water retention area, in what is now the Rocky Glades and Frog Pond, is absolutely essential to ensure water quality while still offering flood control for the areas east of the L-31 and C-111 canals. This plan will still allow adequate flood protection for agriculture while saving Florida Bay and the Florida Key's special way of life.

Sincerely,

Greg Farkas

MR. STEVEN SUTTERFIELD
U.S. ARMY CORPS OF ENGINEERS
P.O.BOX 4970
JACKSONVILLE, FLA
32232-0019

3/30/94

Mr. Sutterfield,

I am writing to support immediate action on Alternative 6A.

After attending a half dozen public hearings with the Corps, I am left with the impression that a "popular comprimise" has been sought by the politicians at the expense of the resource. This delaying tactic is not compatible with the rate of decline in Florida bay and can only result in more costly and complicated solutions.

I am already aware of salt water intrusions into wellfields in certain parts of the county. As the media begins to investigate this threat to our drinking water, I doubt there will a place to hide behind inaction or a public hearing on the matter.

I urge you to buy the lands, fill in C-111 and do the best job that only the best plumbers in the world can do.

JUST DO IT!

Vincent L. Maggio
7980 SW 99 ST
Miami Fl. 33156

Mr. Stephen Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield,

I am writing regarding the C-111 Canal. Please take into consideration the health of the Florida Bay by including the purchase of the Frog Pond and the Rocky Glades

backfilling the end of the existing C-111 canal not discharging fresh water from C-111 into Manatee Bay

replacing the proposed C-111N spreader canal with a water retention/detention area, extend across US-1 (it must be further North)

extending the water retention area North to Tamiami Trail

purchase the 8½ sq mile area to restore fresh water flows to Taylor + Shark River Slough

I am very concerned with preserving the natural beauty of the Florida Keys. Thank you for your consideration and help.

Sincerely,
Sandy D[illegible]

PRINCETON FINANCIAL CORP.
M O R T G A G E   B A N K E R S

March 25, 1994

Mr. Steven Sutterfield
US Army Corps of Engineers
P.O. Box 4970
Jacksonville, Fl 32232-0019

Dear Mr. Sutterfield:

It is my understanding the the US Army Corps is holding a hearing on restoring flows into Taylor Slough and Florida Bay through the proposed C-111 Project.

I am sure you realize this area provides important habitat for endangered species such as the Wood Stork, American Crocodile Cape Sable Sparrow and the Snail Kite. In the last decade problems in the system have been aggravated by water management practices which have overdrained the Everglades and prevented water from going into Florida Bay.

I understand the Corps has reviewed all alternatives and is leaning toward 6A. While this alternative is a good one it can be improved in the following ways

1. The proposed C-111N canal should be designed as a retention/detention area linked to the area to the north.
2. The use of a 500 cfs pump instead of a smaller one at S-332B would allow waters pumped into a larger area along C-111N which would allow natural sheetflow to move down through the southern Everglades area.
3. Expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested by Alternative 8.
4. C-111N should be extended east of US 1 to allow maximum flexibility and water deliveries to all parts of this system.

Your support of these measures will be appreciated.

Gilbert O. Lucas
5315 Glenmore Drive
Lakeland, Fl 33813

215 Imperial Boulevard, Suite A-2, Lakeland, Florida 33803 • (813) 648-1200 • FAX (813) 648-1300

"Registered Mortgage Brokerage Business"

RCH 31, 1994

STEVEN SUTTERFIELD
ARMY CORP OF ENGINEERS
O. BOX 4970
CKSONVILLE, FL 32232-0019

: C-111 PROJECT..RESTORING FLOWS INTO TAYLOR SLOUGH AND FLORIDA
Y

AR MR SUTTERFIELD:

A NATIVE BORN FLORIDIAN AND A AVID FISHERMAN, DIVER, AND TURALIST, I AM IN FAVOR OF ALTERNATIVE 6A AND WISH THAT THE LLOWING IMPROVEMENTS BE MADE:

CANAL C-111 SHOULD BE FILLED AND NO LONGER USED.

PROPOSED CANAL C-111N BE DESIGNED AS A RETENTION/DETENTION AREA NKED TO THE AREA TO TO THE NORTH

CORPS SHOULD USE A 500CFS PUMP INSTEAD OF A 50 CFS PUMP AT S-2B TO ALLOW A NATURAL SHEET FLOW

EXPAND THE RETENTION/DETENTION AREA ALONG THE WEST SIDE OF L-31N RTH TO TAMIAMI TRAIL AS SUGGESTED BY ALTERNATIVE 8.

CANAL C-111N SHOULD BE EXTENDED EAST OF US 1

ANK YOU FOR TAKING THE TIME TO READ MY RECOMENDATIONS AND I HOPE AT THINGS WORK OUT.

NCERELY,

; SUSAN W. HOERBER
53 DONNELLEY DR
NTANA, FL 33462

March 28, 1994
3501 Prado Drive
Sarasota, FL 34235

Mr. Steven Sutterfield
US Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield:

I support Alternative 6A to restore overland flow into southeastern Everglades National Park and the northeast corner of Florida Bay. I regret that the public hearing is held only in a location that allows the local agricultural interests to conveniently attend and testify, but is impractical for other Floridians who have a strong interest in protecting Florida Bay and Everglades National Park as valuable national and, indeed, global resources.

The economic analysis for the project should incorporate the cost of the collapse of Florida Bay and the impact on fishing. The proposed retention/detention area, in what is now the Rocky Glades and Frog Pond is essential for protecting water quality and providing flood control.

The proposed C-111N canal should be designed as a retention/detention area linked to the area to the north to provide flood control. Expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested by Alternative 8. The Corps should use a 500 cfs pump instead of a 50 cfs pump at S-332B so that waters are pumped into a large retention/detention area along C-111N which allows natural sheetflow to move through the Everglades. C-111N should be extended east of US 1 to allow maximum flexibility and water deliveries to all parts of this system.

Sincerely,

Robin L. Hart, Ph.D.

MRS. BENJAMIN B. LITTMAN
18081 BISCAYNE BOULEVARD, NO. 601
NORTH MIAMI BEACH, FLORIDA 33160-2526

March 26, 1994

Dear Mr. Sutterfield

We are unable to attend the March 29 meeting.

We hope alternative 6A can be improved. The C111N canal should be a retention/detention area levee to the north. The corps should use a 500 cfs pump at S-332B. Expand the retention/detention area along the west side of L-31N north to Tamiami Trail. C-111N should be extended east of U.S. 1.

Respectfully,

Ruth N. Littman

Benjamin B. Littman M.D.

Dear Col. Salt,

Thank you for hearing of concern about the future of the Everglades. We would like to see C111 filled in and proposal #6A enacted.

Thank you.

A concerned citizen

Sincerely yours,

Voter # 001471080

Harry [illegible]

28 March 1994
563 Washington Road
Gatlinburg, TN 37738

r. Steven Sutterfield
S Army Corps of Engineers
.O. Box 4970
acksonville, FL 32232-0019

ear Mr. Sutterfield:

am unable to attend the March 29 hearing on restoring flows nto Taylor Slough and Florida Bay through the proposed C-111 roject but I would like to provide a written response.

he Everglades are a national treasure and should be treated in hat way for future generations. The opportunity we have now to orrect the system may be the last for a long time. Wildlife is eing lost or threatened as we procrastinate. C-111 provides ater to not only threatened or endangered species but to an ntire habitat and water must be provided in appropriate amounts t appropriate times.

e must restore the ecological integrity of Taylor Slough and the astern panhandle area of the Everglades (including Florida Bay) nd Alternative 6A will provide operational flexibility for this art of the system. Alternative 6A can be enhanced and the roposed C-111N canal should be designed as a retention/detention rea linked to the area to the north. A 500 cfs pump should be sed instead of a 50 cfs one at S-332B so that waters are pumped nto a large retention/detention area along C-111N which allows a atural sheetflow to move down through the southern Everglades nto the marine environment. Please expand the etention/detention area long the west side of L-31N north to amiami Trail as suggested by Alternative 8. C-111N should be xtended east of US 1 to allow maximum flexibility and water eliveries to all parts of this system.

hanks for your consideration.

W. Eugene Cox

. Eugene Cox

Carolyn Shields

March 28 1994

Steven Sutterfield
US Army Corps of Engineers
PO Box 4970
Jacksonville. FL 32232-0019

Mr. Sutterfield:

re: restoring the flows into Taylor Slough and Florida Bay

The necessity to take action now on the plight of the Everglades life-cycle continues with the hearings on the C-111 system restoration for the Everglades.

C-111 is a *key* avenue for freshwater into the Everglades. Efforts of restoration at this point in the Everglades sheet flow will quantify results of recovery both wildlife and economically to industries around Florida Bay. The C-111 canal should be extended east of US 1 to allow maximum flexibility and water deliveries to all parts of the system.

The Corps of Engineers needs to be a forerunner in the recovery of the Everglades, which is now on the minds of more Floridians than ever. The restoration of the Kissimmee Basin is underway; this continues those identical efforts at the other end of the sheet flow. While the system's operation from inbetween will be the real battle, these two milestones will squeeze the pus out of the pimple.

Sincerely,

C. Shields

Carol Shields

4631 Wenhart Road Lake Worth Florida 33463-6942

HENRY LEE MORGENSTERN
ATTORNEY AT LAW

TELEPHONE: (305) 294-7838
FAX: (305) 294-4711

624 WHITEHEAD STREET
KEY WEST, FLORIDA 33040

March 24, 1994

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

RE: Public hearing on C-111 Project

Dear Mr. Sutterfield,

We in Monroe County appreciate the need to save Florida Bay in a very personal way. But the Bay is also a national resource that all Americans need to keep healthy for future generations.

Thank you for your leadership on this project, and please say YES to Alternative 6A.

In addition, please make the following improvements:

1. Design C-111N as a retention/detention area.

2. Use a 500 cfs pump instead of a 50 cfs pump at S-332B to allow a greater and more natural sheet flow along C-111N.

3. Expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested in Alternative 8.

4. Extend C-111N east of Highway 1.

I thank you, and my children thank you.

Very truly yours,

HENRY LEE MORGENSTERN

9955 South Forestline Avenue
Inverness, FL 34452
March 24, 1994

Mr. Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield:

I am writing to express my concern about the future health of the Everglades National Park. This vital link in the viability of an enormous ecological system is on the verge of collapse. Many factors have contributed to this collapse, one of them being the system of canals and dikes that divert water away from the Everglades.

I understand that some alternatives to the present water diversion projects have been proposed. I would like to urge you to adopt Alternative 6A which would increase the operational capacity and flexibility of the C-111 system. This would help restore the ecological integrity of Taylor Slough and the eastern panhandle area of the Everglades.

I would also urge that the retention/detention area along the west side of L-31N north to Tamiami Trail be increased, as suggested in Alternative 8. Canal C-111 N should be designed as a retention/detention area linked to the north to help reestablish historic timing and distribution of sheetflow to this part of the Everglades.

Lastly, I feel it is imperative that Frog Pond and Rocky Glades agricultural area be purchased to help further preserve the Everglades/Florida Bay system. For too long we have let these agricultural interests dominate the decisions about where and how Florida's precious water supplies are used. It's time to give the water back to the natural ecosystem it is a part of.

Thank you for listening to my views. I would like to be informed about what decisions are finally reached concerning this issue by the Army Corps of Engineers.

Sincerely,

Martha Clutter

Miss Martha Clutter

MARCH 24, 1994

MR. STEVEN SUTTERFIELD
US ARMY CORPS OF ENGINEERS
P.O. BOX 4970
JACKSONVILLE, FLORIDA 32232

RE: HEARING ON THE RESTORING WATER FLOWS INTO TAYLOR SLOUGH AND FLORIDA BAY THROUGH C-111 PROJECT.

DEAR MR. SUTTERFIELD:

I AM A CONCERNED CITIZEN WHO WILL BE UNABLE TO ATTEND THE MEETING IN HOMESTEAD ON MARCH 29TH REGARDING THE ABOVE MENTIONED PROJECT. I DO WISH TO PLACE MYSELF AMONG THOSE WHO BELIEVE THAT THE NATIONAL AUDUBON SOCIETY HAS SOME SUGGESTIONS WHICH MAY BE OF VALUABLE ASSISTANCE.

1- THE BEST ALTERNATIVE APPEARS TO BE 6A, BUT THIS COULD BE AMELIORATED BY ADOPTING SOME OF THE FOLLOWING:

A- TO ENSURE FLOOD PROTECTION TO COMMUNITIES TO THE NORTH, AS WELL AS RESTORE HISTORIC TIMING AND DISTRIBUTION OF SHEETFLOW IN THIS PART OF THE EVERGLADES, THE PROPOSED C-111N CANAL SHOULD BE DESIGNED AS A RETENTION\DETENTION AREA LINKED TO THE AREA TO THE NORTH.

B- TO EXPAND THE RETENTION\DETENTION AREA ALONG THE WEST SIDE OF L-31N NORTH TO TAMIAMI TRAIL AS SUGGESTED BY ALTERNATIVE 8. ONLY BY DOING THIS WILL THE CORPS ENSURE THAT ENOUGH CLEAN WATER CAN BE MADE AVAILABLE IN HISTORIC PATTERNS FOR BOTH SHARK AND TAYLOR SLOUGH.

C- C-111N SHOULD BE EXTENDED EAST OF US 1 TO ALLOW MAXIMUM FLEXIBILITY AND WATER DELIVERIES TO ALL PARTS OF THIS SYSTEM.

THANK YOU VERY MUCH FOR YOUR TIME, AND I KNOW THAT YOU WILL ATTEMPT TO COMBINE ALL THESE SUGGESTIONS INTO A SOUND AND FAIR PROGRAM WHICH WILL BE BENEFIT ALL FLORIDIANS.

SINCERELY YOURS
[signature]
PAUL E. MATELIS

March 27, 1994

To Mr. Sutterfield,

After reviewing information on the restoration of flows into the Taylor Slough and Florida Bay through the proposed C-111 Project I encourage you to support the 6A ~~[illegible]~~ alternative. 6A provides operational flexibility for this part of the system. It also provides the same amount of flood protection as Alt. 9.

Farmers of the Frog Pond area over the last decade have successfully prevailed upon the government to give them more & more drainage benefits not provided by law. Because of this the Park and Florida Bay have been harmed. When Frog Pond is drained adjacent marshes in Taylor Slough will be drained. Therefore purchase of the Frog Pond and Rocky Glades agricultural area contemplated by this proposal is essential to the future of the Everglades/Fl. Bay system. To help save the economy of the Florida Keys 6A and 8* are the best plans.

Thank you for your time.

Sincerely,
Joyce [illegible]

* To expand the retention/detention area on the west side of L-31N.

U. S. Army Corps of Engineers
P. O. Box 4970
Jacksonville, Florida 32232-0019

Att: Mr. Steven Sutterfield

Re: Water flow restoration to eastern Everglades and Florida Bay.

Dear Sir;

As a nature tour guide who shows our natural areas and wildlife to many persons each year, I am vitally concerned with the health of the Everglades and Florida Bay. Since my arrival in 1954, I have seen both bird and fish populations in the affected area drop by as much as 95 percent. A healthy system would restore our dying grass beds, which are the breeding grounds of our many aquatic species, large and small. These species are the base of our entire sport fishing and shrimping industries and the food supply of our formerly huge avian population. A healthy system would return our wildlife and enhance the tourist industry so vital to Florida.

In reviewing your various plans for the restoration of sheet water flow to the eastern Everglades, it seems to me that plan 6A has the best chance of success. But to prevent continued water loss to the Taylor Slough area of the Everglades and restoration of a natural sheet water flow to Florida Bay, it is essential to create a buffer zone by the purchase of the Frog Pond and Rocky Glades agricultural areas.

While alternative 6A is a good plan, I feel it can be improved by those methods:

1. Canal C-111 should be at least partially filled in to raise ground water levels in the near Everglades and prevent massive surges of farm-poisoned water from reaching and further ruining Barnes Sound.

2. The proposed C-111N canal should be implemented as a retention area to the north and as a protection to the nearby community.

3. Larger pumps, 500cfs, should replace the 50cfs pump at S-332B to increase the flow into the retention area along C-111N to allow the natural sheet flow to reach Florida Bay.

4. Expand the retention area along the west side of L-31N north to the Tamiami Trail. Only by doing this can enough clean water be supplied to restore historic patterns of water to both the Shark Valley and Taylor Sloughs.

Yours truly,

A. Morton Cooper, Jr.

A. Morton Cooper, Jr.
7625 SW 97th Court
Miami, Florida 33173-3133

Orange Audubon Society
(A Chapter of National and Florida Audubon Societies)
P.O. Box 1142, Maitland, FL 32751

March 28, 1994

Mr. Steven Sutterfield
US Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

RE: Water flow restoration, Taylor Slough and Florida Bay

Dear Mr. Sutterfield:

The Board of Directors of Orange Audubon Society has asked me to write you concerning the above mentioned issue. Orange Audubon is a chapter of both National and Florida Audubon Societies located in Orange County with a membership of approximately 1900 individuals and families. We are <u>all</u> concerned about the Everglades and are committed to its restoration.

We congratulate you on your choice of Plan 6A which provides flood protection to agricultural interests, provides the greatest benefit to the environment and maximizes operational flexibility. Please stick to your guns and restore fresh water flow into a system that served Florida long before agricultural interests were a question.

We ask you to consider the following improvements to Plan 6A that expand and underscore your commitment to this endangered environment.

* Design the proposed C-111N canal as a water retention/detention area linked to the area to the north. This will help restore sheet flow and ensure flood protection to the northern communities.

* Use a 500 cfs pump at S-332B allowing waters to be pumped into a large water retention/detention area along C-111N. This provides for natural sheetflow to move south into the marine environment and provides flood protection.

* Alternative 8 allows for enough clean water to enter both Shark Slough and Taylor Slough by expanding the water retention/detention area along the west side of L-31N, north to Tamiami Trail, thus restoring historic water patterns.

* Extend C-111N east of US1 to allow maximum flexibility and water deliveries to all parts of this system.

10305 NW 5th St
Plantation Fl 33324
March 25, 1994

Mr. Steven Sutterfield
US Corps of Engineers
PO Box 4970
Jacksonville Fl 32232-0019

Dear Mr. Sutterfield:

I am in favor of restoring natural water flows into Taylor Slough and Florida Bay through the proposed C-111 Project, alternative 6-A.

With the press of a large population in south Florida and the certainty of that population doubling, land areas become more vulnerable to human use. What more valuable use than preserving our food chain which could be helped if we are careful and wise in this project.

While Alternative 6-A is good, it could be improved. Please consider: designing the C-111N Canal as a retention/detention area linked to the northern area; extending C-111N east of U.S. 1; and expanding the retention/detention area along the west side of L-31N to Tamiami Trail.

Thanks for your time

Sincerely,
Cynthia Hollar

MARCH 25, 1994

MR. STEVEN SUTTERFIELD
US ARMY CORPS OF ENGINEERS
P.O. BOX 4970
JACKSONVILLE, FL. 32232-0019

RE: C-111 PROJECT - RESTORING FLOWS INTO TAYLOR SLOUGH AND FLORIDA BAY

DEAR MR. SUTTERFIELD:

THERE IS GOING TO BE A PUBLIC HEARING AT HOMESTEAD ON THE 29th OF MARCH. I CANNOT ATTEND BUT WOULD LIKE TO LET YOU KNOW BY THIS LETTER THAT I AGREE WITH THE CORPS OF ENGINEERS THAT ALTERNATIVE 6A MEET THE CRITERIA TO PROVIDE OPERATIONAL FLEXIBILITY FOR THIS PART OF THE SYSTEM.

AND IT CAN BE IMPROVED IN THE FOLLOWING WAYS:

- To more fully ensure flood protection to communities to the north, as well as restore historic timing and distribution of sheetflow in this part of the Everglades, the proposed C-111N canal should be designed as a retention/detention area linked to the area to the north.
- The Corps should use a 500 cfs pump instead of a 50 cfs one at S-332B so that waters are pumped into a large retention/detention area along C-111N which allows natural sheetflow to move down through the southern Everglades area into the marine environment. This provides ecological benefits while allowing for greater flood protection as well.
- Expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested by Alternative 8. Only by doing this will the Corps ensure that enough clean water can be made available in historic patterns for both Shark Slough and Taylor Slough.
- C-111N should be extended east of US 1 to allow maximum flexibility and water deliveries to all parts of this system.

Martha B. Roy
MARTHA B. ROY
5201 N.W. 4 AVE.
POMPANO BEACH, FL. 33064

2404 Antigua Circle, Apt. X-4
Coconut Creek, Fl 33066

April 13, 1994

Mr. Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970

Dear Sir:

Re: Everglades/Florida Bay Restoration.
Re-establish Freshwater Flows to Taylor Slough and Florida Bay.

I have been requested by the ational Wildlife, as a member of that ganization, to write to you in support of Canal 111 Project.

I am enclosing a page of their letter with their suggestions for improvement in the Project.

Sincerely,
Pauline Wachtel

Encl.
NWF letter

The Corps reviewed 10 alternatives including a no action alternative, and alternatives 6A, 8 and 9. The Corps found that Alternative 6A meets all of the criteria to provide operational flexibility for this project. The tomato farmers offered Alternative 9 which does not provide flexibility to restore natural water levels along the boundary and headwaters of upper Taylor Slough. Also, Alternative 9 does not control the timing of water flows into Taylor Slough -- essential to re-establishing the historic freshwater flows in this area. The Corps noted that Alternative 6A provides the same amount of flood protection as the farmers proposal. The Corps chose Alternative 6A because it provides the greatest benefit to the environment, maximizes operational flexibility and provides flood damage prevention capability to agriculture.

Points You Can Make About the Proposal

- (The proposal includes the purchase of the Frog Pond and Rocky Glades agricultural area, which is essential to the future of the Everglades/Florida Bay ecosystem.

In the last decade, farmers in the Frog Pond area have successfully prevailed upon the government to give them more and more drainage benefits not provided by law. By providing these tax-funded benefits, the Corps and The South Florida Water Management District have severely harmed Everglades National Park and Florida Bay, because when they drain the Frog Pond the adjacent marshes in Taylor Slough are also drained.

- √ The proposed retention/detention area, in what is now the Rocky Glades and Frog Pond, is essential to ensuring water quality in this area and for providing flood control for areas east of L-31/C-111 canals.

- √ The economic analysis for this project is flawed because it does not incorporate the cost of the collapse of Florida Bay vs. the benefits of restoring the Bay.

The health of the economy of S. Florida is completely dependent on the quality of the environment. The degradation of Florida Bay has endangered the economy of the entire Florida Keys. Monroe County's economy is based on commercial and recreational fishing, diving and tourism-based businesses. Scientists agree that re-establishing freshwater flows to the Everglades is absolutely essential to the restoration of Florida Bay. Because Canal 111 is a major avenue for providing freshwater into Florida Bay, the benefits of economic recovery and viability to these industries in Monroe County should be quantified in the economic analysis of the Corps' Canal 111 Project, to further justify the economic benefits of restoring historic hydrologic conditions.

While Alternative 6A is a good one it can be improved in the following ways:

- √ The proposed Canal 111N should be designed as a retention/detention area linked to the area to the north, to more fully ensure flood protection to communities to the north, and to restore the historic timing and distribution of sheet flow in this part of the Everglades.

- √ The Corps should use a 500 cfs (cubic feet/second) pump instead of a 50 cfs pump at S-332B so that waters are pumped into a large retention/detention area along C-111N. This would allow natural sheetflow to move down through the southern Everglades area into the marine environment, providing ecological benefits while allowing for greater flood protection.

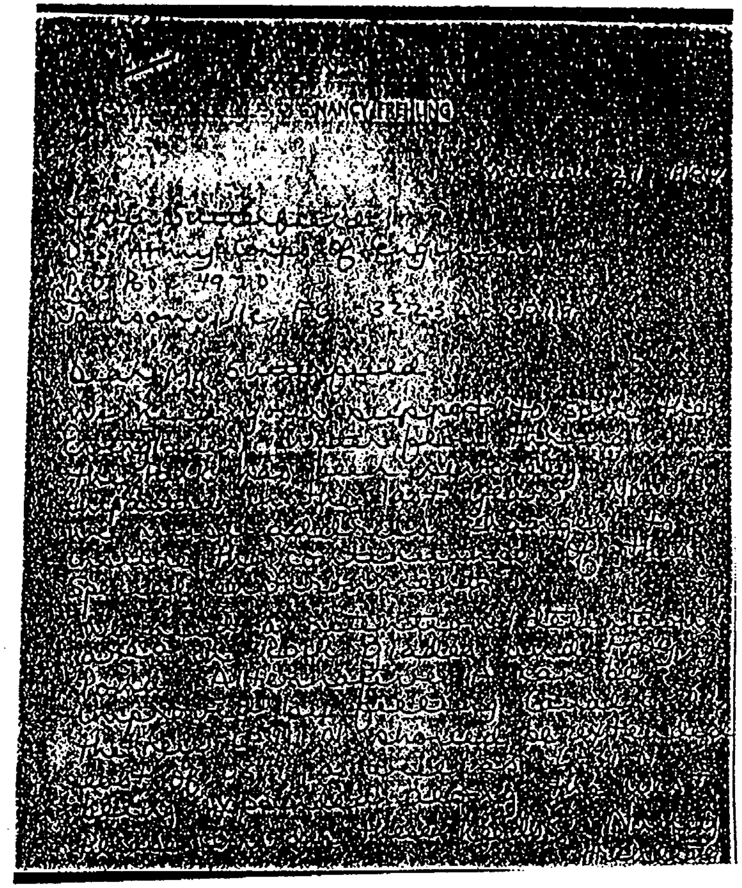
- √ The Corps should expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested in Alternative 8. Only by doing this will the Corps ensure that enough clean water can be made available in historic patterns for both Shark and Taylor Sloughs.

- √ Canal 111N should be extended east of U.S. Highway 1 to allow for maximum flexibility and water deliveries to all parts of this system.

Thank you for raising your voice for the Everglades/Florida Bay,

Carolyn Waldron
Director

Please share this letter with a friend:
Reuse and then Recycle



March 27, 1994

Mr. Steven Sutterfield
U.S. Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Sutterfield:

I am writing because of my grave concern about the very serious problems in the Everglades and the Florida Bay. Now that these huge problems are finally being addressed, I hope the courses of action chosen are agressive enough to allow adequate solutions. Which brings me to the project being undertaken to select a plan to increase the operational capability & flexability of the C-111 system & thereby the Taylor Slough + eastern panhandle area of the Everglades.

I feel the Corps' selection of Alternative 6A is a good one for the most part, but does not adequately consider the potential cost of the collapse of

Florida Bay vs restoring it. [illegible] that aspect is factored in [illegible] the endangerment of the entire [illegible] economy there would be muc[illegible] additional justification for resto[illegible] historic conditions. Since scientis[illegible] agree the restoration of fresh [illegible] flows is absolutely essential [illegible] Bay restoration and since the C[illegible] District have caused great harm to both the Park & Ba[illegible] by providing far more drainag[illegible] benefits to the Frog Pond area fa[illegible] than the law required, and because the drainage of the Fro[illegible] Pond area is tied to the Tay[illegible] Slough, steps must now be taken to remedy this [illegible] situation. Therefore, purcha[illegible] of the Frog Pond and Rocky Gle[illegible] agricultural areas contemplated [illegible] this proposal is essential.

In addition, I feel alterna[illegible] 6A should be strengthened by [illegible]
[illegible]

canal to be a retention/detention area linked to the area to the north

2. extending the C-111N area east of US I to allow maximum flexibility and water delivery

3. Expanding the retention/detention area along the west side of L-31N north to Tamiami Trail to ensure enough clean water can be made available to both Shark + Taylor sloughs

4. Utilizing a 500 cfs pump instead of a 50cfs pump at S-332 B so larger amounts of water would be in a retention/detention area along C-111N to allow natural sheet-flow to move down through the southern Everglades into the marine environment to provide both environmental benefits + greater flood control.

Thank you for your attention to my comments

Sincerely,
June R. Long, [illegible]
3633 Myakka, [illegible] 33718

Points you can make about the proposal: Mr. Sutterfield;

The economic analysis for this project is flawed because it does not incorporate the cost of the collapse of Florida Bay vs. the benefits of restoring it. The degradation of Florida Bay has endangered the economy of the entire Florida Keys which is based on large part on fishing and diving. Scientists agree restoration of freshwater flows is absolutely essential to restoration of the Bay. Since the C-111 area is a key avenue for input of freshwater into Florida Bay, the benefits of economic recovery to these industries in Florida Bay should be quantified and will add additional economic justification for restoring historic conditions.

In the last decade farmers in the Frog Pond area have successfully prevailed upon the government to give them more and more drainage benefits not provided by law. By providing these benefits, the Corps and District have harmed the Park and Florida Bay, because when they drain the Frog Pond they also drain the adjacent marshes in Taylor Slough. Therefore, purchase of the Frog Pond and Rocky Glades agricultural area contemplated by this proposal is essential to the future of the Everglades/Florida Bay system.

The proposed retention/detention area, in what is now the Rocky Glades and Frog Pond, is essential to ensuring water quality in this area as well as providing flood control for areas east of L-31/C-111 canals.

While Alternative 6A is a good one it can be improved in the following ways.

- To more fully ensure flood protection to communities to the north, as well as restore historic timing and distribution of sheetflow in this part of the Everglades, the proposed C-111N canal should be designed as a retention/detention area linked to the area to the north.
- The Corps should use a 500 cfs pump instead of a 50 cfs one at S-332B so that waters are pumped into a large retention/detention area along C-111N which allows natural sheetflow to move down through the southern Everglades area into the marine environment. This provides ecological benefits while allowing for greater flood protection as well.
- Expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested by Alternative 8. Only by doing this will the Corps ensure that enough clean water can be made available in historic patterns for both Shark Slough and Taylor Slough.
- C-111N should be extended east of US 1 to allow maximum flexibility and water deliveries to all parts of this system.

Please try to restore the Everglades, protect Florida Bay + Keys, not just drain for tomato growers!

Carol L. Sellers, P.O. Box [illegible], B[illegible]

3/25/94

Mr. Steve Sutterfield
US Army Corps of Engineers

Sir:
Being too far away to attend the public hearing on 3/29 I write endorsing ways in which Alternative 6A can be made truly effective

John K. Mahon

John K. Mahon
4129 SW 2nd Ave
Gainesville FL 32607

Background: C-111 is in the far southeast region of the Everglades system. It is the key area for providing overland flows into southeastern portion of Everglades National Park and the northeast corner of Florida Bay. This area provides important habitat for endangered species such as the Wood Stork, Cape Sable Sparrow, American Crocodile and the Snail Kite. However, the ditching and draining of this area has disrupted the natural timing, distribution and flow of water. Instead of a gentle sheet of water, fed by rain, moving slowly through this area, canals drain water out of marshes and quickly out of the system. In the last decade problems in the system have been aggravated by water management practices which have overdrained the Everglades and prevented water from going into Florida Bay - all to benefit a few tomato growers in the area known as the Frog Pond. This over draining has done visible and significant harm to the Everglades/Florida Bay and prevented vital freshwater flows from reaching the key areas of the Bay.

How you can help:

1. Attend the public hearing on March 29
2. Attend the public hearing on March 29 and write a letter to the Corps of Engineers
3. Write a letter to the corps of engineers

You can help by attending the public hearing at Homestead on the 29th. It is clear that the

posed retention/detention area, in what is now the Rocky Glades and Frog Pond, is
l to ensuring water quality in this area as well as providing flood control for areas
-31/C-111 canals.

lternative 6A is a good one it can be improved in the following ways.

To more fully ensure flood protection to communities to the north, as well as restore historic timing and distribution of sheetflow in this part of the Everglades, the proposed C-111N canal should be designed as a retention/detention area linked to the area to the north.

The Corps should use a 500 cfs pump instead of a 50 cfs one at S-332B so that waters are pumped into a large retention/detention area along C-111N which allows natural sheetflow to move down through the southern Everglades area into the marine environment. This provides ecological benefits while allowing for greater flood protection as well.

Expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested by Alternative 8. Only by doing this will the Corps ensure that enough clean water can be made available in historic patterns for both Shark Slough and Taylor Slough.

C-111N should be extended east of US 1 to allow maximum flexibility and water deliveries to all parts of this system.

You can help by attending the public hearing at Homestead on the 29th. It is clea agricultural community intends to turn out many of its workers to oppose this restoratic and is using scare tactics to recruit homeowners from other areas of South Dade County can't attend the hearing then please submit written comments, prior to April 20, 1994, to:

Mr. Steven Sutterfield
US Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

<u>What the Corps proposes:</u> This project is being undertaken to select a plan to increas operational capability and flexibility of the C-111 system to provide restoration for the ecol integrity of Taylor Slough and the eastern panhandle area of the Everglades. The project n maintain existing authorized levels of flood protection for agricultural interests adjacent to C-111. Restoration of these flows will provide freshwater necessary for restoring Florida B Corps recognizes that the present system is harming the ecology of the southeastern Everg

SERVANCY
1450 Merrihue Drive • Naples, Florida 33942 • (813) 262-0304 • Fax (813) 262-5872

April 4, 1994

r. Steven Sutterfield
.S. Army Corps of Engineers
.O. Box 4970
acksonville, Florida 32232-0019

e: Restoration of flows into Taylor Slough and Florida Bay through the proposed C-111 project

ear Mr. Sutterfield:

The Conservancy, Inc. (TCI) strongly supports the ngoing efforts to restore natural water flows to the verglades. With this in mind, we believe that the efforts o restore the ecological integrity of Taylor Slough and the astern panhandle of the Everglades by increasing the perational capability and flexibility of the C-111 system s critical to achieving this goal. Of the options valuated by the U.S. Army Corps of Engineers (ACE), TCI oncurs with your agency's finding that option 6A meets all he criteria to provide the needed flexibility to release resh water into the Everglades and Florida Bay without owering flood protection for farmers. This is the option CI believes should be adopted.

In weighing the economics of your decision, ACE must onsider the cost of the collapse of Florida Bay versus the ost of restoring it. The economy of the Florida Keys very uch depends on the health of Florida Bay. The purchase of he Frog Pond and Rocky Glades as considered by this roposal will also reduce drainage in marshes adjacent to aylor Slough and provide for water quality improvement and lood control.

Additional modifications that would improve option 6A hould also be given serious consideration. To prevent lugs of agricultural and urban runoff canal C-111 should be lugged or filled. The proposed C-111N canal should be esigned as a retention/detention area linked to the orthern area. This would provide flood protection for ommunities to the north and restore historic timing and istribution to this part of the Everglades. ACE should use larger pump 500 cfs vs. 50 cfs) at S-332B to pump waters nto a large detention area along C-111N to allow natural heetflow to the southern Everglades and Florida Bay. The

retention area west of L-31N north to the Tamiami Trail should be expanded as suggested in option 8. This will help insure an adequate water supply in the historic pattern for both Taylor Slough and Shark Slough. Finally C-111N should be extended east of U.S. 1 to permit maximum flexibility and water deliveries to all of part of this system.

TCI appreciates the opportunity to provide comment on this important step in restoring adequate and properly timed fresh water flow to the Everglades and Florida Bay. There is indeed only one Everglades!

Sincerely,

John H. Fitch, Ph.D.
President

6001 Pelican Bay Bl - Naples FL 3391
April 5, 1994

Mr Steven Sutterfield
US. Army Corps of Engineers
P.O. Box 4970
Jacksonville Fl 32232-0019

Comments:

While Alternative 6A is a good one, it can be impro in the following ways:

— C-111N canal should be desig as a detention/retention area: lin to the area to the north

— The Corps should use a 500 C pump instead of a 50 cfs pro ecological benefits while allow for greater flood protection as w

— Expand retention/detention ar along west side of L-31N nor to Tamiami Trail - Then clean water can be made available fo both Shark Slough & Taylor Slou

2/

C-111N should be extended east of US 1 to maximize flexibility and water deliveries to all parts of the system.

Thank you for taking the time to read this. We hope you consider the changes.

Sincerely yours,
Bertram S and
Nancy L Silver

Mr. & Mrs. Gerald Gura
5657 Willow Creek Lane
Delray Beach, FL
33484

3/30/94

Mr. Steven Sutterfield
U.S. Army Corp of Engineers
P.O. Box 4970
Jacksonville, Fl 32232

Dear Mr. Sutterfield:

On the C111 system please use 6A alternate and follow Audubon suggestions attached.

Thank you

Yours truly,

[signature]

IT AUDUBON EVERG. PHONE No. : Mar.29 1994 3:57PM P01

Cory 6

The best way to prevent the second year of this experiment from continuing to harm the Everglades and Florida Bay, is for the Congressional Natural Resources Committee to hold a field hearing to investigate the mismanagement of the experiment by the Corps and the SFWMD. Reasons for doing so are as follows:

- Despite claims by the Corps and District that more water is being sent to Florida Bay, Everglades National Park scientific studies show that, to the contrary, more water is now being drained from Taylor Slough and diverted from Florida Bay into Barnes Sound and Manatee Bay.

- The SFWMD and the Corps, violated the public trust when they privately agreed to different and more harmful operating criteria for the Demonstration Project than were legally and publicly permitted by the Corps' Finding of No Significant Impact (FONSI).

- The SFWMD and the Corps repeatedly ignored specific requests and recommendations made by Everglades National Park and substituted their own provisions which inflicted great harm on Taylor Slough and Florida Bay.

- In November 1993, the SFWMD and the Corps created an artificial "dry season" for a nearby special interest (South Dade Land Corporation and its tomato farming tenants) by draining water from Taylor Slough and surrounding areas more than 3 months before they would have naturally receded. This amounts, in effect, to delivering a public benefit to a private interest -- drainage to assist them in making more money from agriculture -- that far exceeds what these agencies are legislatively directed or authorized to deliver. And all at the expense of Florida Bay and Taylor Slough which are directly impacted and harmed as a result of these actions.

While Alternative 6A is a good one it must be improved in the following ways.

- To restore historic timing and distribution of sheetflow in this part of the Everglades, as well as more fully ensure flood protection to communities to the north, the proposed C-111N canal should be replaced by a retention/detention area. This retention/detention area should be locate north of the proposed site of the C-111N canal and borrow levee (which, a proposed, would cut off sheetflow from wetlands to the north) and shoul accept stormwater runoff from Homestead and Florida City.

- The Corps should use a 500 cfs pump instead of a 50 cfs one at S-332E so that stormwater runoff from the southern areas of Homestead and Florida City are pumped into the retention/detention area, rather than down the C-111 canal. This will provide full flood protection in a manner that reestablishes natural sheetflow rather than destroying the marine environment (as does use of the C-111 canal during flood events).

- Fill the C-111 canal south of the retention-detention areas. This will eliminate the current disruption of sheetflow (timing and distribution) in the C-111 basin, and prevent unnatural water transfers from the Taylor Slough basin to the C-111 basin.

- Expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested by Alternative 8. Only by doing this will the Corps ensure that enough clean water can be made available in historic patterns for both Shark Slough and Taylor Slough.

- The retention-detention areas which replace C-111N, should be extended east of US Highway 1 to allow maximum flexibility and water deliveries to all parts of the C-111 basin and coastal Everglades.

Dear Mr. Satterfield,

I encourage you to accept alternative 6A for restoration of the C-111 system essential for input into the Florida Bay.

C-111N should be extended east of U.S. 1 to allow maximum natural water flow to all parts of this system.

Sincerely,

Robin DeVaurney
3829 S.W. 148th Place
Ocala, Fla 34473

Terra Systems
ENVIRONMENTAL CONSULTANTS, INC.
2020 Shelfield Road • Post Office Box 9115 • Winter Haven, FL 33883-9115 • (813) 533-0200

April 4, 1994

Mr. Steven Sutterfield
US Army Corps of Engineers
Post Office Box 4970
Jacksonville, FL 32232-0019

Study for Structural and Non-Structural Modifications to the C-111 Basin, South Dade County, Florida

I have reviewed the General Reevaluation Report and Environmental Impact Statement findings with respect to protecting the natural values of Everglades National Park while maintaining the flood control in the basin. I would like to offer my support in favor of implementing the proposed project which would allow the continuation of the Taylor Slough iteration of the Experimental Program to restore more natural hydrological conditions in the Everglades.

However, based on the National Audubon Society's review I would like to offer the following points for consideration:

- The proposed retention/detention area, in what is now the Rocky Glades and Frog Pond is essential to ensuring water quality in this area as well as providing flood control for areas east of L-31/C-111 canals.
- While Alternative 6A is a good one it can be improved in the following ways:
  - To more fully ensure flood protection to communities to the north, as well as restore historic timing and distribution of sheetflow in this part of the Everglades, the proposed C-111N canal should be designed as a retention/detention area linked to the area to the north.
  - The Corps should use a 500 cfs pump instead of a 50 cfs one at S-332B so that waters are pumped into a large retention/detention area along C-111N which allows natural sheetflow to move down through the southern Everglades area into the marine environment. This provides ecological benefits while allowing for greater flood protection as well.

  - Expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested by Alternative 8. Only by doing this will the Corps ensure that enough clean water can be made available in historic patterns for both Shark Slough and Taylor Slough.
  - C-111N should be extended east of US 1 to allow maximum flexibility and water deliveries to all parts of this system.

Thank you for your attention to this very important issue.

Sincerely,

TERRA SYSTEMS ENVIRONMENTAL
CONSULTANTS, INC.

TJ Coburn

TJ Coburn, President and
Senior Ecologist

TJC:tfe:WP51\M\LTR.16

Mr. Sutterfield,
It seems the story repeats itself over and over.
"It destroys what Mother nature has created".
Would be nice to give back some of what man

AUDUBON SE REGIONAL OFFICE

has taken from the Everglades. Florida fights for

ACTION ALERT

wetlands but in my area, I am seeing these areas

NATIONAL AUDUBON SOCIETY

clear cut and at times filled in. When do we

MARCH 18, 1994

begin to listen to what we know must be
done to protect what it seems to take to

Urgent Everglades/Florida Bay Action Alert

protect man in the long run?
Good Luck. Ann Garrett

The US Army Corps of Engineers is holding a hearing on restoring flows into Taylor Slough and Florida Bay through the proposed C-111 Project.

March 29, 1994
7:00 pm
Homestead High School
351 S.E. 12 Street
(East of Hwy 1)
For information about buses, call Theresa Ashley at (305) 296-3880

Background: C-111 is in the far southeast region of the Everglades system. It is the key area for providing overland flows into southeastern portion of Everglades National Park and the northeast corner of Florida Bay. This area provides important habitat for endangered species such as the Wood Stork, Cape Sable Sparrow, American Crocodile and the Snail Kite. However, the ditching and draining of this area has disrupted the natural timing, distribution and flow of water. Instead of a gentle sheet of water, fed by rain, moving slowly through this area, canals drain water out of marshes and quickly out of the system. In the last decade problems in the system have been aggravated by water management practices which have overdrained the Everglades and prevented water from going into Florida Bay - all to benefit a few tomato growers in the area known as the Frog Pond. This over draining has done visible and significant harm to the Everglades/Florida Bay and prevented vital freshwater flows from reaching the key areas of the Bay.

How you can help:

1. Attend the public hearing on March 29
2. Attend the public hearing on March 29 and write a letter to the Corps of Engineers
3. Write a letter to the corps of engineers

You can help by attending the public hearing at Homestead on the 29th. It is clear that the agricultural community intends to turn out many of its workers to oppose this restoration project and is using scare tactics to recruit homeowners from other areas of South Dade County. If you can't attend the hearing then please submit written comments, prior to April 20, 1994, to:

Mr. Steven Sutterfield
US Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

What the Corps pr... This project is being undertaken to select a plan to increase the ... of the C-111 system to provide restoration for the ecological

National Audubon Society
Southeast Regional Office
102 East Fourth Avenue
Tallahassee, FL 32303

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U.S. Postage
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Tallahassee, FL
Permit 462

MS. ANN GARRETT
PO BOX 431
CRESTVIEW, FL 32536-0431

The Corps reviewed 10 alternatives including a no action alternative, and alternatives 1-6A, 8 and 9. The Corps found that alternative 6A met all of the criteria to provide operational flexibility for this part of the system. The tomato farmers offered Alternative 9 which did not provide flexibility to restore natural water levels along the boundary and headwaters of upper Taylor Slough or to control the timing flows into Taylor Slough - essential to the restoration of historic flows in this area. The Corps noted that Alternative 6A provides the same amount of flood protection as the farmers proposal. The Corps chose Alternative 6A because it provides the greatest benefit to the environment, maximizes operational flexibility and provides flood damage prevention capability to agriculture.

Points you can make about the proposal:

- The economic analysis for this project is flawed because it does not incorporate the cost of the collapse of Florida Bay vs. the benefits of restoring it. The degradation of Florida Bay has endangered the economy of the entire Florida Keys which is based on large part on fishing and diving. Scientists agree restoration of freshwater flows is absolutely essential to restoration of the Bay. Since the C-111 area is a key avenue for input of freshwater into Florida Bay, the benefits of economic recovery to these industries in Florida Bay should be quantified and will add additional economic justification for restoring historic conditions.
- In the last decade farmers in the Frog Pond area have successfully prevailed upon the government to give them more and more drainage benefits not provided by law. By providing these benefits, the Corps and District have harmed the Park and Florida Bay, because when they drain the Frog Pond they also drain the adjacent marshes in Taylor Slough. Therefore, purchase of the Frog Pond and Rocky Glades agricultural area contemplated by this proposal is essential to the future of the Everglades/Florida Bay system.
- The proposed retention/detention area, in what is now the Rocky Glades and Frog Pond, is essential to ensuring water quality in this area as well as providing flood control for areas east of L-31/C-111 canals.
- While Alternative 6A is a good one it can be improved in the following ways.
  - To more fully ensure flood protection to communities to the north, as well as restore historic timing and distribution of sheetflow in this part of the Everglades, the proposed C-111N canal should be designed as a retention/detention area linked to the area to the north.
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  - C-111N should be extended east of US 1 to allow maximum flexibility and water deliveries to all parts of this system.

AUDUBON SE REGIONAL OFFICE

ACTION ALERT

NATIONAL AUDUBON SOCIETY

MARCH 18, 1994

Urgent Everglades/Florida Bay Action Alert

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March 29, 1994
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Mr. Steven Satterfield
US Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

What the Corps proposes: This project is being undertaken to select a plan to increase the operational capability and flexibility of the C-111 system to provide restoration for the ecological integrity of Taylor Slough and the eastern panhandle area of the Everglades. The project must maintain existing authorized levels of flood protection for agricultural interests adjacent to C-111. Restoration of these flows will provide freshwater necessary for restoring Florida Bay. The Corps recognizes that the present system is harming the ecology of the southeastern Everglades.

Corps reviewed 10 alternatives including a no action alternative, and alternatives 1-6A, 8 and The Corps found that alternative 6A met all of the criteria to provide operational flexibility for part of the system. The tomato farmers offered Alternative 9 which did not provide flexibility to restore natural water levels along the boundary and headwaters of upper Taylor Slough or control the timing flows into Taylor Slough - essential to the restoration of historic flows in this a. The Corps noted that Alternative 6A provides the same amount of flood protection as the ners proposal. The Corps chose Alternative 6A because it provides the greatest benefit to the ironment, maximizes operational flexibility and provides flood damage prevention capability agriculture.

...ts you can make about the proposal:

The economic analysis for this project is flawed because it does not incorporate the cost of the collapse of Florida Bay vs. the benefits of restoring it. The degradation of Florida Bay has endangered the economy of the entire Florida Keys which is based on large part on fishing and diving. Scientists agree restoration of freshwater flows is absolutely essential to restoration of the Bay. Since the C-111 area is a key avenue for input of freshwater into Florida Bay, the benefits of economic recovery to these industries in Florida Bay should be quantified and will add additional economic justification for restoring historic conditions.

In the last decade farmers in the Frog Pond area have successfully prevailed upon the government to give them more and more drainage benefits not provided by law. By providing these benefits, the Corps and District have harmed the Park and Florida Bay, because when they drain the Frog Pond they also drain the adjacent marshes in Taylor Slough. Therefore, purchase of the Frog Pond and Rocky Glades agricultural area contemplated by this proposal is essential to the future of the Everglades/Florida Bay system.

The proposed retention/detention area, in what is now the Rocky Glades and Frog Pond, is essential to ensuring water quality in this area as well as providing flood control for areas east of L-31/C-111 canals.

While Alternative 6A is a good one it can be improved in the following ways.

- To more fully ensure flood protection to communities to the north, as well as restore historic timing and distribution of sheetflow in this part of the Everglades, the proposed C-111N canal should be designed as a retention/detention area linked to the area to the north.
- The Corps should use a 500 cfs pump instead of a 50 cfs one at S-332B so that waters are pumped into a large retention/detention area along C-111N which allows natural sheetflow to move down through the southern Everglades area into the marine environment. This provides ecological benefits while allowing for greater flood protection as well.
- Expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested by Alternative 8. Only by doing this will the Corps ensure that enough clean water can be made available in historic patterns for both Shark Slough and Taylor Slough.
- C-111N should be extended east of US 1 to allow maximum flexibility and water deliveries to all parts of this system.

58051
HAWLEY K. SMITH
5430 WOODBINE TERRACE
JACKSONVILLE FL 32211

National Audubon Society

JOEL N. KUTZ
695 Spanish Drive S.
Longboat Key, Florida 34228
(813) 383-4542

3/24/94

Mr. Steven Satterfield
U.S. Corps of Engineers
PO Box 4970
Jacksonville, FL 32232-0019

Dear Sir,

The purpose of this letter is to let you know that I am one more citizen of Florida concerned about the degradation of our everglades area. I believe the Corps should do more to restore the everglades to its natural condition. The enclosed clipping, which I'm sure you have seen, explains ideas which I think deserve your favorable consideration.

Very truly yours,
Joel N. Kutz

Urgent Everglades/Florida Bay Action Alert

he US Army Corps of Engineers is holding a hearing on restoring flows into Taylor Slough and .orida Bay through the proposed C-111 Project.

March 29, 1994
7:00 pm
Homestead High School
351 S.E. 12 Street
(East of Hwy 1)
For information about buses, call Theresa Ashley at (305) 296-3880

ickground: C-111 is in the far southeast region of the Everglades system. It is the key area for oviding overland flows into southeastern portion of Everglades National Park and the northeast rner of Florida Bay. This area provides important habitat for endangered species such as the Wood ork, Cape Sable Sparrow, American Crocodile and the Snail Kite. However, the ditching and aining of this area has disrupted the natural timing, distribution and flow of water. Instead of a ntle sheet of water, fed by rain, moving slowly through this area, canals drain water out of irshes and quickly out of the system. In the last decade problems in the system have been aggra-:ted by water management practices which have overdrained the Everglades and prevented water m going into Florida Bay - all to benefit a few tomato growers in the area known as the Frog nd. This over draining has done visible and significant harm to the Everglades/Florida Bay and :vented vital freshwater flows from reaching the key areas of the Bay.

w you can help:

1. Attend the public hearing on March 29
2. Attend the public hearing on March 29 and write a letter to the Corps of Engineers
3. Write a letter to the corps of engineers

do more to restore the everglades to its natural condition. The enclosed clipping, which I'm sure you have seen, explains ideas which I think deserve your favorable consideration.

Very truly yours,
Joel N. Kutz

Karen Swanson
2555 PGA Blvd. #47
Palm Beach Gardens, Fl
33410

r. Steven Sutterfield
S. Army Corps of Engineers
P.O. Box 4970
acksonville, Fl. 32232-0019

ear Mr. Sutterfield:

I would like to make some points about the roposal to restore flows into Taylor Slough and Florida Bay through the proposed C-111 Project.

• The Economic analysis for this project is flawed because it does not incorporate the cost of the collapse of Florida Bay vs. the benefits of restoring it. The degradation of Florida Bay has endangered the economy of the entire Florida Keys which is based on large part on fishing & diving.

• In the last decade farmers in the Frog Pond area have successfully prevailed upon the government to give them more and more drainage benefits not provided by law. By providing these benefits, the Corps and District have harmed the Park and Florida Bay, because when they drain the Frog Pond they also drain

②.

the adjacent marshes in Taylor Slough.

• The proposed retention/detention area in ~~inooe~~ what is now the Rocky Glades and Frog Pond is essential to ensuring water quality in this area as well as providing flood control for areas east of L-31/C-~~3~~111 canals.

• While Alternative 6A is a good one it can be improved in the following ways.

• To more fully ensure flood protection to communities to the north, as well as restore historic timing and distribution of sheetflow in this part of the Everglades, the proposed C-111N canal should be designed as a retention/detention area linked to the area to the north.

• The Corps should use a 500 cfs pump instead of a 50 cfs one at S-332B so that waters are pumped into a large retention/detention area along C-111N which allows natural sheetflow to move down through the southern Everglades area into the marine environment. This provides ecological benefits while allowing for greater flood protection as well.

(3)

- Expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested by Alternative 8. Only by doing this will the Cops ensure that enough ~~water~~ clean water can be made available in historic patterns for both Shark Slough and Taylor Slough.

- C-111N should be extended east of US1 to allow maximum flexibility and water deliveries to all parts of this system.

Thank You

Karen Swanson

Karen Swanson

Dear Mr. Sutterfield,

I favor the acceptance of Alternative 6A for restoration of the C-111 system, essential for input into FL. Bay. C-111N should be extended East of U.S. 1 to allow maximum natural water flow to all parts of this system. I hope you will support this very important system.

Sincerely,

[redacted]

Mary Gehring
5132 S.E. 184th CT.
Ocklawaha, FL- 32179

3703 Fallen Timber
Louisville, Ky. 40241

April 11, 1994

Col. Terrence Salt
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Florida

Dear Col. Salt,

We have just returned from a trip to the Everglades. They are dying!! The commercial and recreational fishing industry, not to mention wildlife, depends on the changes you can make.

Please reintroduce historical amounts of fresh water to Florida Bay, in the historic places and

at the historic times. The C
and the District must deter
the historic natural water
of the Bay and then meet
Please implement the plans
lined for Taylor Slough/C
Basin and Shark Slough, by
Audubon Society and other
vironmental groups. No M
draining of wetlands for
agriculture.!! Please im
ment the Shark Slough S
Design Memorandum, or its
plan, with changes to retu
water flows to historic p
Thank you!.

Sincerel
John D Candar
McBrid

March 30, 1994

Mr. Sutterfield
US Army Corps of Engineers

Dear Sir:

I attended the hearing in Homestead last night. I have been reading about the Florida Bay situation in the papers for some years, and my friends in the Keys have been hit hard. Last night was pretty heated, and I wanted to thank Col. Sault (I hope I have spelled his name correctly) and the Corps staff for their attention.

I have lived in Florida since 1955, and our area is each day under more stress. Much of the proposed plan sounds fine — I only wish something could be done more quickly. Though agricultural land is at a premium — so much of it has been rezoned to housing — There is still land: but There's only one bay. Its problem is all of our problem, not just the fishermen.

One thing that came up over and over again. Please, close down C 111 so that it can't be used to pump fresh water into Manatee Bay. We need

(2)

to set up retention areas in the southea[st] as well. We are just beginning to see the fight for water down here. The retention lands would provide flexibility, help with salinity intrusion, and be a great buffer. Also this would allow even more water to return to the normal westward course — Florida Bay needs as much as possible to get back its old Taylor Slough.

The curtain wall sounds like yet another expensive boondoggle. To keep pockets of land being farmed in areas where they will need to place pressu[re] on the Water District to drain extra for them, or to wangle extra water, is to ask for trouble. The border area can only be farmed at the expense of the bay and the natural water flow.

How soon can we move more water through Taylor Slough? We're coming into the dry season, and I find it difficult to express how concerned I am.

Please let me know what to do.

Sincerely,

LConesa

LILLIAN CONESA
209 NW 60 CT
MIAMI FL 33126

VOTER # 00017432:

Ruth H Clark
1120 Seminole Dr # 4
Fort Lauder, FL 33304-4545

March 29, 1994

Mr. Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

or Homestead, FL Hearing

Re: Restoring Flows into Taylor Slough, Everglades National Park, and Florida Bay

The public interest is best served by purchasing the Frog Pond and Rocky Glades areas needed to put into effect Alternative 6A without further delay. The U.S.C.O.E. must provide the quantity of freshwater to an expanded retention-detention area to ensure water quality in this area as well as providing flood control for areas east of L-31/C111 canals. Scientists agree that providing sheet flow distribution and as close to natural timing as possible to the Taylor Slough marshes is the key to restoration of the ecological integrity of Taylor Slough and the southeastern Everglades to Florida Bay.

The true cost of continued degradation of Florida Bay from lack of freshwater is more than will be spent to buy the necessary wetland retention-detention areas. The cost of losing the juvenile fish and shellfish nurseries and the wildlife(including the last 10% of wading birds who depend upon this part of the food chain), is not quantified properly in the economic analysis for this project. Public interest on a national and international level reflects itself economically here.

Suggestions to improve alternative 6A should be explored: 1) To improve linkages to the north; 2) To extend water deliveries east of U.S. 1; 3) To increase the size of pump at S-332B; and 4) to expand the area (see Alternate 8) to ensure enough clean water in historic patterns for both Shark Slough and Taylor Slough.

We must correct the hydrologic mistakes and planning and zoning mistakes that endanger our water resources and food chain for future generations.

Yours truly,

Ruth H. Clark

Ruth H. Clark

Copies to
SFWMD Chairman
LWV
ECBC
Friends of the Everglades

Lake Region Audubon Society

March 23, 1994

Mr. Steven Sutterfield
US Army Corps of Engineers
P. O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Sutterfield,

Although we cannot attend the public hearing in Homestead on March 29, our 658 members are vitally interested in restoring the Everglades ecosystem. Historic flows of water into Taylor Slough and Florida Bay are an important step in restoration. We ask you to consider the following points when making your decision.

- The degradation of Florida Bay has endangered the economy of the entire Florida Keys. This economy is based largely on fishing, diving, and tourism. Since C-111 is a key avenue for freshwater flow in Florida Bay, the benefits of economic recovery to these businesses depending on the bay should be quantified and will add economic justification for restoring historic water conditions.

- Purchase of the Frog Pond and Rocky Glades agricultural area is essential to the future of the Everglades/Florida Bay ecosystem.

Although Alternative 6 is a good proposal it can be improved in the following ways:

- The proposed C-111N canal should be designed as a retention/detention area linked to the area to the north to ensure flood protection to communities. This will also restore historic timing and distribution of sheetflow of water in this area of the Everglades.

- Increase the size of the pump to 500 cfs at S-332B so that waters are pumped into a large retention/detention area along C-111N. This allows natural sheetflow to move through the southern Everglades area into the marine environment.

- Expand the retention/detention area along the west side of L-31N north to Tamiami Trail as suggested by Alternative 8. By doing this, enough clean water will be available in historic patterns for both Shark Slough and Taylor Slough.

- C-111N should be extended east of US 1 to allow maximum flexibility and water deliveries to all parts of this system.

115 Lameraux Road • Winter Haven • Florida • 33884

Printed on recycled paper using soy inks.

The Corps has a long history of draining and ditching the Everglades at the urgings of state and federal government. This is a part of Florida history from which we can learn. Environmental mistakes are extremely costly to remedy. We urge you now to set this history aside and begin the restoration of the Everglades for future generations.

Sincerely,

Linda Cooper

Linda Cooper
Corresponding Secretary
Lake Region Audubon Society

AMANDA EVERETTE
535 E 44th ST
SAVANNAH GA 31405

MR. STEVEN SUTTERFIELD
US ARMY CORPS OF ENGINEERS
PO BOX 4970
JACKSONVILLE FL 32232-0019

31 MARCH 1994

DEAR MR. SUTTERFIELD:

I AM WRITING TO YOU ABOUT THE C-111 SYSTEM. I WOULD LIKE TO MAKE A FEW POINTS ABOUT THE PROPOSAL:

1) THE ECONOMIC ANALYSIS FOR THIS PROJECT IS FLAWED BECAUSE IT DOES NOT INCORPORATE THE COST OF THE COLLAPSE OF FLORIDA BAY VS. THE BENEFITS OF RESTORING IT. THE DEGRADATION OF FLORIDA BAY HAS ENDANGERED THE ECONOMY OF THE ENTIRE FLORIDA KEYS WHICH IS BASED ON LARGE PART FISHING AND DIVING. SCIENTIST AGREE RESTORATION OF FRESHWATER FLOWS IS ESSENTIAL TO RESTORATION OF THE BAY. SINCE THE C-111 AREA IS A KEY AVENUE FOR INPUT OF FRESH WATER INTO FLORIDA BAY, THE BENEFITS OF ECONOMIC RECOVERY TO THESE INDUSTRIES IN FLORIDA BAY SHOULD BE ~~[illegible]~~ QUANTIFIED

(2)

AND WILL ADD ADDITIONAL ECONOMIC JUSTIFICATION FOR RESTORING HISTORIC CONDITIONS.

2) IN THE LAST DECADE FARMERS IN THE FROG POND AREA HAVE SUCCESSFULLY PREVAILED UPON THE GOVERNMENT TO GIVE THEM MORE AND MORE DRAINAGE BENEFITS NOT PROVIDED BY LAW. BY PROVIDING THESE BENEFITS, THE CORPS AND DISTRICT HAVE HARMED THE PARK AND FLORIDA BAY, BECAUSE WHEN THEY DRAIN THE FROG POND THE ALSO DRAIN THE ADJACENT MARSHES IN TAYLOR SLOUGH. THEREFORE, PURCHASE OF THE FROG POND AND ROCKY GLADES AGRICULTURAL AREA CONTEMPLATED BY THIS PROPOSAL IS ESSENTIAL TO THE FUTURE OF THE EVERGLADES/FLORIDA BAY SYSTEM.

3) THE PROPOSED RETENTION/DETENTION AREA, IN WHAT IS NOW THE ROCKY GLADES AND FROG POND, IS ESSENTIAL TO ENSURING WATER QUALITY IN THIS AREA AS WELL AS PROVIDING FLOOD CONTROL FOR AREAS EAST OF L-31/C-111 CANALS

ALTERNATIVE 6A IS GOOD, BUT NEEDS IMPROVEMENT AND CAN BE IMPROVED IN THE FOLLOWING WAYS:

1) TO MORE FULLY ENSURE FLOOD PROTECTION TO COMMUNITIES TO THE NORTH, AS WELL AS RESTORE

HISTORIC TIMING AND DISTRIBUTION OF SHEETFLOW IN THIS PART OF THE EVERGLADES, THE PROPOSED C-111N CANAL SHOULD BE DESIGNED AS A RETENTION/DETENTION AREA LINKED TO THE AREA TO THE NORTH.

2) THE CORPS SHOULD USE A 500 CFS PUMP INSTEAD OF A 50 CFS ONE AT S-332B SO THAT WATERS ARE PUMPED INTO A LARGE RETENTION/DETENTION AREA ALONG C-111N WHICH ALLOWS NATURAL SHEETFLOW TO MOVE DOWN THROUGH THE SOUTHERN EVERGLADES AREA INTO THE MARINE ENVIRONMENT. THIS PROVIDES ECOLOGICAL BENEFITS WHILE ALLOWING FOR GREATER FLOOD PROTECTION AS WELL.

3) EXPAND THE RETENTION/DENTION AREA ALONG THE WEST SIDE OF L-31N NORTH TO TAMIAMI TRAIL AS SUGGESTED BY ALTERNATIVE 8. ONLY BY DOING THIS WILL THE CORPS ENSURE THAT ENOUGH CLEAN WATER CAN BE MADE AVAILABLE IN HISTORIC PATTERNS FOR BOTH SHARK SLOUGH AND TAYLOR SLOUGH.

4) C-111N SHOULD BE EXTENDED EAST OF US 1 TO ALLOW MAXIMUM FLEXIBILITY AND WATER DELIVERIES TO ALL PARTS OF THIS SYSTEM.

THANK YOU.

IN ECOLOGY,

AMANDA EVERETTE

April 14, 1994

Dear Mr. Sutterfield,

I encourage you to accept Alternative 6A for restoration of the C-111 system, essential for the flow into the Florida Bay. C-111N should be extended east of US 1 to allow maximum natural water flow to all parts of this system.

Sincerely,

Lorraine K

Lorraine Klein
P.O. Box 850
Altoona, FL 32702

March 27, 1994

Patricia B. Miller
2500 N.E. 19 Avenue
Wilton Manors, Florida 33305

Steven Sutterfield
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Fl. 32232-0019

Dear Mr. Sutterfield:

I am writing in support of the Florida Audubon Society's efforts to save Florida Bay. I have lived in South Florida since 1937 and have watched the destruction of so many of our natural Resources. I am unable to attend the hearing in Homestead

3/29/94

Dear Mr. Butterfield

Proceeding restoration for the ecological integrity of Taylor Slough & the eastern area of the Everglades is an absolute necessity. We drove the highway years ago, took a water-boat ride, saw the birds - and a crocodile! Exquisite!! 2 years ago we flew over it on our way to Miami to catch a flight to Spain - we were appalled at the sight. Returning at night, we were horrified to see the lights of houses & moving cars along a roadway! As a resident of Fl., I am impelled to urge action not to sacrifice this unique gift to nature, to our state. Very truly yours Mrs. Ruth H. Radimersky

30 March '94

Dear Mr. Butterfield:

The health of the Everglades and Florida Bay is important to all of us. Floridians and others.

It seems shortsighted of your long-range policy to allow farmers to use the fertile land of the eastern panhandle of the Everglades to grow tomatoes (in short [illegible] sugarcane).

I have confidence in the National Audubon Society's studies and recommendations regarding the Everglades - in this case Alternative 6-A - with consideration of its recommendations for improvements.

Irene [illegible]

8 April, 1994

Dear Mr. Butterfield,

I wish to express my support for Canal 111 Project, Alternative 6A or even an improvement over 6A: Design the proposed Canal 111 N. as a retention/detention area linked to the area to the north; Use a 500 cfs pump instead of a 50 cfs pump at S-332B. Also, expand the retention/detention area along the west side of L-31 N to Tamiami Trail as suggested in Alternative 8. Also extend Canal 111 N east of U.S. Highway 1.

Very truly yours,

Katherine M. Clark

E5

Dear Mr. [illegible] [illegible]

I appreciate that the Corps is moving in the right direction for restoring water flow into Taylor Slough and Florida Bay to return to ecological integrity. Of the proposed alternatives regarding Project C-111 I support your choice of 6A which appears the best one among the ten. However, to prevent further drainage leaving Park and Florida Bay it is absolutely essential to purchase Frog Pond and Rocky Glades areas. That proposed retention/detention area will also ensure water quality.

Furthermore, I urge you to pay close attention to suggestions by the Audubon Society how to improve Alternative 6A, namely that 1) C-111 N canal should be a retention/detention area; 2) a larger pump at S-332 B would allow ecological benefits and greater flood protection; 3) expansion of retention/detention area west of L-31 N as proposed in Alternative 8; 4) C-111 N should be extended east of US [illegible]

Thank you.

[illegible]

April 7, 1994

Dear Mr. Sutterfield,

I must express my support for Canal 111 Project, Alternative 6A – or even an improvement over 6A: Design Canal 111N as a retention/detention area linked to the area to the North; Use a 500 cfs pump instead of a 50 cfs pump at S-332B. Also, expand the retention/detention area along the west side of L-31N north to Tamiami Trail. Also, extend Canal 111N east of U.S. Highway 1.

[illegible]

Mr. [illegible] Sutterfield
U.S Army Corps of Engineers

Dear Mr. Sutterfield:

I encourage you to accept alternative 6A for restoration of the C-111 system, essential for input into the Florida Bay. C-111N should be extended east of U.S. 1 to allow maximum natural water flow to all parts of this system.

Sincerely,

Betty Olson
4300 SW. 43 Ct.
Ocala, Fla 3447

8 April, 1994

Dear Mr. Satterfield,

I wish to express my support for Canal 111 Project, Alternative 6A or even an improvement over 6A: Design the proposed Canal 111 N as a retention/detention area linked to the area to the north; use a 500 cfs pump instead of a 50 cfs pump at S-332B. Also, expand the retention/detention area along the west side of L-31 N to Tamiami Trail as suggested in Alternative 8. Also extend Canal 111 N east of U.S. Highway 1.

Very truly yours,

Katherine M. Clark

E5

Dear Mr. Satterfield [illegible]

[illegible]

Accept [illegible]

[illegible] pumps

[illegible] Bay.

[illegible] C111N should be extended east of U.S. 1 to allow the maximum [illegible] flow to all parts of the system.

I appreciate all you can do to help preserve this small piece of Earth.

Nancy Faith Weman MacFarlan

3115 SE 165 Ct. Rd.

Silver Springs FL 34488

ANNEX B

C-111

SECTION 404(b)(1) EVALUATION

ANNEX B

SECTION 404(b)(1) EVALUATION

FINAL

SECTION 404(B) CLEAN WATER ACT EVALUATION

CANAL 111 (C-111), SOUTH DADE COUNTY, FLORIDA

I. Project Description

a. Location. The Canal 111 (C-111) Basin, is located in southern Florida. The area of focus is located in southeastern Dade County. The study area's northern boundary is a line drawn east from S-331, the divide control structure, and west on the southern limit of the eight-and- one-half square mile area and west by Shark River Slough located in ENP. The eastern boundary varies generally along a line through the ridge structures S-194 and S-196 to Homestead and then parallels Card Sound Road. The southern boundary is Florida Bay.

b. General Description

Authority and Purpose. In 1968, the ENP-South Dade Conveyance Canals Project was authorized by PL 90-483, Flood Control Act of 1968. The Act authorized modifications to the existing Central and Southern Flood Control Project as authorized by the 1948 Flood Control Act and 1962 Flood Control Act in the interest of improved conservation and distribution of available water and extended flood protection. A major purpose of this project was for conservation and conveyance of water supplies to meet the long-term needs of urban and agricultural users and the ENP. Improvements to the L-31N borrow canal and a new pump station S-331 enabled delivery of water to Taylor Slough, via L-31W and a new pump station S-332, and the Park's eastern panhandle, via C-111, to meet minimum water deliveries to ENP mandated by PL 91-282. No improvements were required in C-111 to handle the increased water supply.

General Description of Dredged or Fill Material

(1) General Characteristics of Material. Material will be removed from existing spoil mounds along the south side of Canal 111 (C-111) and used to construct a levee-roadway that would run roughly parallel to Levee 31N (L-31N). The material is sandy with limestone inclusions. Tie-back levees will be constructed at structures. Canals

109 and 110 will be plugged. Miscellaneous fill of earth, stone and concrete will be done at structures.

(2) Quantity of Material (cu. yds.)
Tie-back levees: 567,000 cy
Backfill canals: 810,000 cy
Miscellaneous earth fill at structures: 132,400 cy
Stone fill at structures: 21,000 cy
Concrete fill: 37,400 cy

(3) Source of Material. The material was dredged from the Everglades substrate to construct C-111. It is now in mounds along the south side of C-111. Excavations will be made at structures, and suitable fill will be used for construction.

Description of the Proposed Discharge Site

(1) Location (map). The location is shown on Figures 1, 2, and 3.

(2) Size (acres). 29 acres would be filled with levees. About 200 acres will be filled around structures.

(3) Type of Site (confined, unconfined, open water). The levee construction sites are unconfined, open Everglades rocky prairie that is intermittently flooded.

(4) Type(s) of Habitat. The habitat is rocky glades. Vegetation in the rocky glades is primarily comprised of thinly scattered sawgrass (*Cladium jamaicensis*), spikerush (*Eleocharis cellulosa*), and beakrushes (*Rhynchospera* spp.) on marl soils in association with muhly (*Muhlenbergia* sp.) prairies.

(5) Timing and Duration of Discharge. Work would require 1-2 years, with discharge made preferably in the dry season.

f. Description of Disposal Method The material will be trucked to the road and levee site and dumped. Subsequently it will be moved and smoothed with earthmoving equipment. In some cases, e.g., at structure sites, excavated material will be used at the site.

II. Factual Determinations (Section 230.11)

Physical Substrate Determinations

(1) Substrate Elevation and Slope. The elevation is between 5 and 7 feet, NGVD, and there is almost no slope.

(2) Sediment Type. The substrate at the construction site is limestone rock overlain with marl soil.

(3) Dredged/Fill Material Movement. There will be no appreciable movement of material. It will rest on limestone rock.

(4) Physical Effects on Benthos. All benthos in the fill site will be covered, smothered and killed.

(5) Other Effects. An effect would be the formation of an area of upland. Natural uplands that occur in the Everglades are tree islands. The fill, however would be used as an access road, and woody vegetation would be kept from the crown.

(6) Actions Taken to Minimize Impacts (Subpart H). Precautions to confine the fill to the desired roadway-levee alignment will be taken. Existing access roads would be used.

b. Water Circulation, Fluctuation and Salinity Determinations

(1) Water. Water would flow parallel to the levee and through the water control structures.

(a) Salinity. The area is fresh water, and this condition would remain unchanged.

(b) Water Chemistry. No changes.

(c) Clarity. After construction ends, clarity would be as before. During construction, turbidity would be generated in the very slowly-to nonmoving water.

(d) Color. No effect.

(e) Odor. No effect.

(f) Taste. No effect.

(g) Dissolved Gas Levels. The material is essentially clean soil; there would be moderate biochemical oxygen demand, and no change in dissolved gases.

(h) Nutrients. Old spoil material has weathered over several years in mounds, and it contains no larger levels of nutrients than are found in existing waters and soils in the area. Material to be dredged to form canals and canal berms is limestone and marl.

(i) Eutrophication. No cause for eutrophication.

(j) Others as Appropriate. None.

(2) Current Patterns and Circulation.

(a) Current Patterns and Flow. The water now flows very slowly in a southeasterly direction, except when the S-332 pumps are operating. The levee and detention-retention area would divert water southward.

(b) Velocity. The velocity is essentially zero.

(c) Stratification. None.

(d) Hydrologic Regime. The area is characterized by an historic average hydroperiod of 6 to 7 months, but the hydroperiod now is apparently shorter.

(3) Normal Water Level Fluctuations. Two feet deep to -3 feet.

(4) Salinity Gradients. None.

(5) Actions That Will Be Taken to Minimize Impacts (Subpart H). Precautions to confine the fill to the desired berm-levee alignment will be taken. Existing access roads would be used.

c. Suspended Particulate/Turbidity Determinations

(1) Expected Changes in Suspended Particulates and Turbidity Levels in Vicinity of Disposal Site. Temporary, during construction. Fill material has little organics, hence very low quantities of suspendable material.

(2) Effects on Chemical and Physical Properties of the Water Column.

(a) Light Penetration. Temporary attenuation during construction. Afterward, none.

(b) Dissolved Oxygen. No effect. No BOD, and light attenuation effects would be short and negligible.

(c) Toxic Metals and Organics. None.

(d) Pathogens. None.

(e) Aesthetics. No effect, because there are few observers. Post-construction effect of visible pump stations, canals, levees. The canals would support bank vegetation, fish and wildlife

(f) Others as Appropriate. None.

(3) Effects on Biota.

(a) Primary Production, Photosynthesis. No effect, because light attenuation from very briefly suspended particulates would be negligible.

(b) Suspension/Filter Feeders. Those confined to water in solution holes of the limestone, or unable to move, would be covered with the fill. Effects on the biological communities would be essentially none.

(c) Sight Feeders. Same as above.

(4) Actions taken to Minimize Impacts (Subpart H). Precautions to confine the fill to the desired berm-levee alignment will be taken. Existing access roads would be used.

d. Contaminant Determinations. None present.

e. Aquatic Ecosystem and Organism Determinations (Subpart G)

(1) Effects on Plankton. None, except under the fill.

(2) Effects on Benthos. None, except under the fill.

(3) Effects on Nekton. None.

(4) Effects on Aquatic Food Web. None.

(5) Effects on Special Aquatic Sites. The construction area is in the Everglades, adjacent to Everglades National Park. The project effect would be restoration of historic environmental conditions to the Park.

(a) Sanctuaries and Refuges. As stated above.

(b) Wetlands. Wetland functions and form would be restored to some degree as a result of the project.

(c) Mud Flats. None.

(d) Vegetated Shallows. These are the marl prairies described above. Historic, natural conditions would be restored to the extent possible.

(e) Coral Reefs. None.

(f) Riffle and Pool Complexes. None.

(6) Threatened and Endangered Species. Coordination under the Endangered Species Act has been initiated. The project, at this stage, is in full compliance with the Endangered Species Act.

(7) Other Wildlife. Wading birds would benefit from significant restoration effects.

(8) Actions to Minimize Impacts. Precautions to confine the fill to the desired roadway-levee alignment will be taken. Existing access roads would be used.

f. Proposed Disposal Site Determinations

(1) Mixing Zone Determination. The mixing zone would likely be less than 10 yards, because of slow flow rate and very small fraction of suspendable material.

(2) Determination of Compliance with Applicable Water Quality Standards (present the standards and rationale for compliance or non-compliance with each standard). All standards will be complied with, unless a variance should be required for unforeseen reasons. A Section 401 water quality certification will be sought from the State of Florida.

(3) Potential Effects on Human Use Characteristics. Non-consumptive uses, such as bird watching, would be enhanced. Long-term contribution to improved sport fishing in Florida Bay.

(a) Municipal and Private Water Supply. No effect.

(b) Recreational and Commercial Fisheries. The project would contribute to long term improvement by increasing fresh water flow at correct times into Florida Bay.

(c) Water Related Recreation. Little to no effect.

(d) Aesthetics. Small direct effect, due to few observers. Long term contribution to restored wading bird populations in Everglades National Park.

(e) Parks, National and Historical Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves. The project is intended to restore ecological values to the southeastern portion of Everglades National Park.

g. Determination of Cumulative Effects on the Aquatic Ecosystem. To the extent that the project for Modified Water Deliveries to Everglades National Park is implemented successfully, that project and this should interact synergistically to provide significant restoration of ecological integrity to the southeast Everglades.

h. Determination of Secondary Effects on the Aquatic Ecosystem. All benefits to flora and fauna would be secondary, in that the direct effects would be hydrological, but the secondary effects would be ecological and beneficial.

III. Findings of Compliance or Non-Compliance With the Restrictions on Discharge.

a. No significant adaptations of the guidelines were made relative to this evaluation.

b. The alternative that will be selected from among an array of practicable alternatives will be that which best meets the study objectives. It is probable that no practicable alternative is possible that will not involve discharge of fill into waters of the United States.

c. The discharge of fill materials will not cause or contribute to, after consideration of disposal site dilution and dispersion, violation of any Florida water quality standards. The discharge operation will not violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

d. The placement of fill material will not jeopardize the continued existence of any species listed as threatened or endangered or result in the likelihood of destruction or adverse modification of any critical habitat designated under the Endangered Species Act of 1973, as amended.

e. The placement of fill materials will not result in significant adverse effects on human health and welfare, municipal and private water supplies, recreational and commercial fishing, plankton, fish, shellfish, wildlife, wetlands and special aquatic sites. The life stages of aquatic species and other wildlife will not be adversely affected. Significant adverse effects on aquatic ecosystem diversity; productivity and stability; and recreational, aesthetics, and economic values will not occur.

f. Appropriate steps to maximize positive impacts on aquatic systems will be included in plans for the recommended plan.

ANNEX C

C-111

FLORIDA COASTAL ZONE MANAGEMENT PLAN

CONSISTENCY EVALUATION

FLORIDA COASTAL ZONE MANAGEMENT PLAN CONSISTENCY DETERMINATION

1. Chapter 161, Beach and Shore Preservation.

The intent of the coastal construction permit program established by this chapter is to regulate construction projects located seaward of the line of mean high water and which might have an effect on natural shoreline processes.

Response: Construction will not be located seaward of the line of mean high water or where it might have an effect on natural shoreline processes.

2. Chapters 186 and 187, State and Regional Planning.

These chapters establish the State Comprehensive Plan which sets goals that articulate a strategic vision of the State's future. Its purpose is to define in a broad sense goals and policies that provide decision-makers directions for the future and provide long-range guidance for an orderly social, economic and physical growth.

Response: The studied project would enhance environmental quality, and it would not adversely affect social, economic and physical growth.

3. Chapter 252, Disaster Preparation, Response and Mitigation.

This chapter creates a state emergency management agency, with the authority to provide for the common defense; to protect the public peace, health and safety; and to preserve the lives and property of the people of Florida.

Response. This statute is not applicable to the project.

4. Chapter 253, State Lands.

This chapter governs the management of submerged state lands and resources within state lands. This includes archeological and historical resources; water resources; fish and wildlife resources; beaches and dunes; submerged grass beds and other benthic communities; swamps, marshes and other wetlands; mineral resources; unique natural features; submerged lands; dredged material disposal islands; and artificial reefs.

Response: Each type of resource protected under this statute is addressed in the EIS. Full conformance and compliance with the requirements for protecting these resources is intended.

5. Chapters 253, 259, 260, and 375, Land Acquisition.

These chapters authorize the State to acquire land to protect environmentally sensitive areas.

Response: State acquisition of lands at the eastern edge of Everglades National Park may be necessary for protection of environmentally sensitive lands within the Park.

6. Chapter 258, State Parks and Aquatic Preserves.

This chapter authorizes the State to manage State parks and preserves. Consistency with this statute would include consideration of projects that would directly or indirectly adversely impact park property, natural resources, and park programs management or operations.

Response: None affected.

7. Chapter 267, Historic Preservation.

This chapter establishes the procedures for implementing the Florida Historic Resources Act responsibilities.

Response: The study has been coordinated with the Florida State Historic Preservation Officer. Historic preservation compliance will be completed to meet all responsibilities under Chapter 267. The State Historic Preservation Officer has commented on the project plans (Annex A).

8. Chapter 288, Economic Development and Tourism.

This chapter directs the State to provide guidance and promotion of beneficial development through encouraging economic diversification and promoting tourism.

Response: Contribution from the study area to the State's tourism economy will not be compromised by project implementation.

9. Chapters 334 and 339, Public Transportation.

This chapter authorizes the planning and development of a safe, balanced and efficient transportation system.

Response: No effect.

10. Chapter 370, Saltwater Living Resources.

This chapter directs the State to preserve, manage and protect the marine, crustacean, shell and anadromous fishery resources in State waters; to protect and enhance the marine and estuarine environment; to regulate fishermen and vessels of the State engaged in the taking of such resources within or without State waters; to issue licenses for the taking and processing of products of fisheries; to secure and maintain statistical records of the catch of each such species; and to conduct scientific and economic studies and research.

Response: No direct effect on this State responsibility; a long term benefit is intended.

11. Chapter 372, Living Land and Freshwater Resources.

This chapter establishes the Game and Fresh Water Fish Commission and directs it to manage freshwater aquatic life and wild animal life and their habitats to perpetuate a diversity of species with densities and distribution which provide sustained ecological, recreational, scientific, educational, aesthetic, and economic benefits.

Response: The project would positively affect the specified resources.

12. Chapter 373, Water Resources.

This chapter provides the authority to regulate the withdrawal, diversion, storage and consumption of water.

Response. The plans for withdrawal, diversion, storage and consumption of water are fully coordinated with the State at this stage, and a recommendation would be made with full concurrence from the State.

13. Chapter 376, Pollutant Spill Prevention and Control.

This chapter regulates the transfer, storage, and transportation of pollutants and the cleanup of pollutant discharges.

Response. Potential pollutants may include motor fuels and lubricants. All activities will conform with State regulations.

14. Chapter 377, Oil and Gas Exploration and Production.

This chapter authorizes the regulation of all phases of exploration, drilling, and production of oil, gas, and other petroleum products.

Response: Not applicable to this project.

15. Chapter 380, Environmental Land and Water Management.

This chapter establishes criteria and procedures to assure that local land development decisions include consideration of the regional impacts of proposed large-scale development.

Response. Not applicable to this project.

16. Chapter 388, Arthropod Control.

This chapter provides for a comprehensive approach for abatement or suppression of mosquitoes and other pest arthropods within the State.

Response. The studied project would not produce arthropod pest problems.

17. Chapter 403, Environmental Control.

This chapter authorizes the regulation of pollution of the air and waters of the State by the Department of Environmental Regulation.

Response: Full compliance with State requirements will be accomplished.

18. Chapter 582, Soil and Water Conservation.

This chapter establishes policy for the conservation of the State's soil and water through the Department of Agriculture. Land use policies will be evaluated in terms of their tendency to cause or contribute to soil erosion or to conserve, develop, and utilize soil and water resources both on site or in adjoining properties affected by the project. Particular attention will be given to projects on or near agricultural lands.

Response: The proposed action has the purpose of conserving soil and water resources in a manner that restores historic soil-forming processes in the area. Nearby agricultural interests will be protected from additional flood damages.

ANNEX D

C-111

FISH AND WILDLIFE COORDINATION ACT REPORT

United States Department of the Interior
FISH AND WILDLIFE SERVICE
P.O. BOX 2676
VERO BEACH, FLORIDA 32961-2676

May 31, 1994

Colonel Terrence C. Salt
District Engineer
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Attn: Planning Division

Dear Colonel Salt:

The U.S. Fish and Wildlife Service (Service) provides the following Interim Fish and Wildlife Coordination Report on the Integrated General Reevaluation Report and Environmental Impact Statement (GRR/EIS) for the Canal 111 project, Dade County, part of the Central and Southern Florida Flood Control Project, Florida. This report is submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and Section (7)(a)(2) of the Endangered Species Act, as amended (16 U.S.C. 1531 et seq.).

As the Canal 111 project enters Detailed Design phase, the Service will update this report, specifically regarding the environmental effects of the operational criteria established through further fish and wildlife investigations and hydrologic modeling.

The Service fully supports the current project purpose to eliminate excessive freshwater discharges into Barnes Sound and to begin the ecological restoration of Taylor Slough and the Triangle Lands by redirecting freshwater into these stressed marshes situated on the east and west sides of C-111. We view this draft GRR/EIS as a significant step towards ecosystem restoration in the southern Everglades.

BACKGROUND

In 1968, the South Dade Conveyance Canals Project was authorized by PL 90-483, Flood Control Act of 1968. The Act authorized modifications to the existing Central and Southern Florida Flood Control Project as authorized by the 1948 Flood control Act and the 1962 Flood Control Act. A major purpose of the Act was to improve the conservation and conveyance of water resources to meet the long-term needs of urban demands, agricultural users and fish and wildlife resources of the Everglades National Park and surrounding lands.

The Service's primary goal for the project is to find a long-term solution to alleviating the harmful freshwater discharges to Barnes Sound by restoring, through an iterative testing process, a more natural distribution, quantity and timing of hydrologic resources in the region. The redistribution water from this channelized condition to a broader, more naturally timed condition is viewed as a significant step to restoring the ecological integrity of the region.

STATUS OF CURRENT PLANNING

As now proposed, the project would greatly assist with the overall larger issue of ecosystem restoration of the Everglades. The Service understands that the planning schedule must be expedited. The Service supports this expedited process and provided previous comments on the preliminary draft GRR/EIS by letter dated February 7, 1994. The following comments are to supplement those comments and to assist in future project planning.

ALTERNATIVE PLAN SELECTION

While the Corps of Engineers has preliminarily selected Alternative No. 6A as the preferred alternative, final decisions on alternative plan selection will require further refinement and additional planning and testing. We are encouraged that several of the alternatives that are now being considered, specifically Alternatives Nos. 3, 4, 5, and 6, 6A would result in favorable environmental results for the overall study area by spreading water throughout the C-111 basin by structural means and, thereby, moving toward the objectives and goals of the Service for the basin, Florida Bay and adjacent Everglades National Park.

Although we appreciate that your planning process requires you to select a specific alternative, the differences between alternatives have not been completely ecologically tested from an operational mode with additional water delivery. Also, the difference in environmental benefits generated by each alternative as presented in the report does not appear to be significant. Therefore, it appears that it is premature to select a final alternative until an operational plan and testing with additional water deliveries has been completed. The Service concurs with the Corps of Engineers' finding that full environmental benefits cannot be realized from any of the alternatives until additional water supplies are made available.

The Service believes that features found in Alternatives Nos. 3 through 6A and 8 should be considered further as planning progresses. There are indications that several of the features of a given alternative may be combined with another alternative(s) before a final plan is selected, thus maximizing environmental benefits.

RECOMMENDATIONS

The Service, therefore, recommends the following considerations be included in future project planning to enhance environmental benefits and meet the overall goals of ecosystem restoration:

* LOWER C-111 BASIN: Backfilling the lower C-111 Canal below S-18C appears to provide benefits through direct restoration of wetlands and would also help disperse water by sheetflow. The Service recommends that this project feature be fully considered. Also the capacity of the S-332E pump should be enlarged to 250 cfs rather than 50 cfs as a way of eliminating dependency on the lower C-111 basin, and instead reestablishing sheetflow to the marshes south of C-111N.

* TRIANGLE LANDS: The "spreader canal" feature designed to restore hydroperiod to the hypersaline Triangle Lands east of U.S. Highway 1 should be extended under U.S. Highway 1 in order to maximize environmental benefits (enhancement/restoration of approximately 8,000 to 10,000 acres of wetlands) from this project feature. The spreader canal should be positioned as far to the north as possible to maximize this benefit. The Florida DOT originally included provisions for the "spreader canal" in their U.S. Highway 1 widening proposal with the Federal Highways Administration. The spreader canal was to be located at the site of an underpass for the Florida panther, proposed for Mile Marker 122.5.

The Service understands that FDOT is interested in cooperating with the Corps in extending the "spreader canal" under U.S. 1 to the Triangle Lands. Therefore, the Department recommends the Corps continue to investigate opportunities to include this significant ecological restoration component as a project feature.

* WATER QUALITY: Other features should be considered to ensure adequate water quality is maintained prior to discharge into Everglades National Park and waters of the State. Concepts such as "storage treatment areas" should be actively considered.

* LAND ACQUISITION: Several critical areas currently being drained by the L-31N and C-111 systems should be prioritized for acquisition to fully maximize ecosystem benefits. These critical areas include the Frog Pond, Rocky Glades Agricultural Area and the 8-1/2 square mile area. The Department recommends the Corps of Engineers consider the public acquisition of these lands.

* FROG POND: The Department believes that additional improvements can be made in the Frog Pond area to reestablish higher stages in the headwater marshes of Taylor Slough. This should consider a north-south detention area in the central portion of the "Frog Pond". Facilities to cause detention and retention with outflow along the west side, which would provide outflow overbank flow along the west side of the north South portion of L-31W canal. This would require that pumping station S-332D be located at the north end of this detention retention area.

* MONITORING PLAN: The Department notes no clear distinction between the initial predictions of environmental responses that were conducted as part of the pre-construction planning and the follow-up evaluations and monitoring that occur during and following the construction phase. It is essential that a systematic and comprehensive hydrological and ecological monitoring plan be put in place prior to initial construction. We recommend that, at a minimum, an outline of a monitoring plan, with responsible parties identified, be provided in the Final GRR/EIS for review.

The Service recognizes that the success of the C-111 project will depend on the combination of structural and operational changes that are made and on the process by which operational decisions are implemented. The Service proposes that a three-party agreement between the Corps, Interior (NPS and FWS), and the Local Sponsor be required and used to assure that the new structures are operated to maximize ecological restoration to Everglades National Park and the Triangle Lands, and assure that the project has no adverse impacts on endangered and threatened species in the area.

The Service further requests that plans for evaluating and selecting operational plans and implementing monitoring programs during and following the construction phases be jointly developed for Taylor Slough, the C-111 basin and Shark River Slough. This process needs to be elaborated upon in more detail in the final C-111 GRR.

The Service believes that the lack of strong positive ecological benefits among the alternative plans is because the assessments were made for proposed changes in structural design alone. The ultimate potential for of this project for restoring more natural hydrological and ecological conditions will depend on the operational changes that are made. The Corps and cooperating agencies must soon determine what these operation changes will be, and begin the process of evaluating potential ecological responses to the different operational alternatives considered.

ENDANGERED SPECIES

For the above reasons, the Fish and Wildlife Service, concurred with the Corps of Engineers' December 9, 1993 "no effect" determination for the snail (Everglade) kite, wood stork, bald eagle, Eastern indigo snake, American crocodile, and the Florida panther under Section 7(a)(2) of the Endangered Species Act for the footprint of the structural changes and operational features. However, the Service is unable to evaluate effects on the Cape Sable sparrow at this time, except for construction features, and a Biological Opinion may be necessary when operational plans are developed.

CONCLUSIONS

The Service continues to view the C-111 project as an essential step for bringing about ecological restoration of the freshwater marshes and estuaries in Everglades National Park and Triangle Lands. We remain pleased with the recent rapid pace in planning for these improvements for Taylor Slough, Florida Bay and Barnes Sound.

Thank you for the opportunity to provide input on this water resources and ecosystem restoration project. We look forward to continued close coordination throughout all phases of project planning, construction and evaluation.

David L. Ferrell
Field Supervisor

cc:

NPS, Homestead, FL
SFWMD, West Palm Beach, FL
USFWS, Atlanta, GA
NMFS, St. Petersburg,FL
USFWS, Jacksonville, FL
DEP, Tallahassee, FL
FGFWFC, Tallahassee, FL

United States Department of the Interior

OFFICE OF THE SECRETARY
OFFICE OF ENVIRONMENTAL POLICY AND COMPLIANCE
Richard B. Russell Federal Building
75 Spring Street, S.W.
Atlanta, Georgia 30303

May 13, 1994

ER-94/176

A. J. Salem, Chief
Planning Division
Jacksonville District
U. S. Army Corps of Engineers
P. O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Salem:

This letter provides the comments of the U.S. Department of the Interior on the "Draft Integrated General Reevaluation Report and Environmental Impact Statement" for the Canal 111 (C-111) project (February 1994) in south Dade County, Florida. We call your attention to earlier comments on a preliminary draft GRR and EIS for the C-111 project, contained in a letter from the Department dated February 7, 1994. These comments supplement those in the February letter.

The Department supports the adoption and expedited implementation of the recommended alternative plan 6A, contingent on the inclusion of several refinements to the structural design. These refinements include: (1) the extension of the water detention/retention area on a north-south alignment through the central portion of the Frog Pond, (2) a connector canal to convey water from L-31W to C-111 below S-175 and S-177, and (3) an increase in the size of the S-332E pump station, and the careful placement of the C-111N spreader canal. We believe that alternative plan 6A, refined as indicated, is superior to other alternative plans evaluated by the Corps of Engineers for the C-111 project. It has much greater potential for meeting the objectives for Everglades restoration, including re-establishing higher stages in headwater marshes of Taylor Slough, eliminating damaging flood control releases through S-197 into Manatee Bay, and improving the volume, distribution and timing of freshwater flows into eastern Florida Bay.

The addition of a detention/retention cell in the central Frog Pond area is necessary to meet the project's objective of restoring more natural water levels in the Taylor Slough headwaters while providing the authorized level of flood control in the developed areas east of the C-111 canal. We recommend that the L-31W borrow can be retained between S-174 and S-332, so it can be used as an outflow system to the upper detention/retention cell. In this way, excess runoff could be released as overbank flow along the entire reach of the north-south portion of L-31W, or be discharged through the existing S-332 pump station. The proposed S-332D pump station should be located at a point where it can discharge into the top end of this lower (Frog Pond) detention/retention cell. The excess outflow from this cell would be released via S-175 and the existing lower L-31W canal. Much of the land in the western three sections of the Frog Pond represent the original central flow-way of the Taylor Slough watershed. The L-31W canal was aligned in its present location to restore water levels to this area. Removing the L-31W levee system, but retaining the north-south reach of the canal, will allow the delivery of water directly into this original trough, and restore sheetflow along the natural topographic gradients in the upper Taylor Slough basin.

The primary route of canal flow to the lower C-111 basin should be via the lower (Frog Pond) detention/retention cell and the new connection canal between L-31W and C-111. This will provide the same benefits of improved flow timing and water quality to the wetlands of the lower C-111 basin, as is proposed for the Taylor Slough basin. C-111N should be located far enough north as possible to restore public lands north of the new canal without flooding private lands closer to Florida City. The plan for a levee immediately north of the spreader canal should be re-examined, since this will limit the ability to spread water into the public wetlands upstream of the spreader canal. This levee could be better located at the northern extent of the public lands, as a way of protecting the developed areas south of Florida City. Backfilling the lower C-111 Canal below S-18C appears to provide benefits through direct restoration of wetlands and would also help disperse water by sheetflow. The Department recommends that this project feature be fully considered. Also, the capacity of the S-332E pump should be enlarged to 250 cfs rather than 50 cfs as a way of eliminating dependency on the lower C-111 basin and instead reestablishing sheetflow to the marshes south of C-111N.

The Department requests that additional improvements be evaluated during the detail design and operational planning stages of the C-111 project. These include: (1) redesign of the eastern end of C-111N so that water can be delivered east of U.S. Highway One into the "Triangle lands" (contingent upon public acquisition of these lands and the location of new culverts under the highway), (2) permanently severing the connection to the lower portion of C-111 if the enlargement of S-332E can replace the existing gravity drainage, and (3) connecting the L-31W tieback levee and the levee system proposed for the 8.5 square mile area. The "spreader canal" feature designed to restore hydroperiod to the hypersaline Triangle Lands east of U. S. Highway 1 should be extended under U. S. Highway 1 in order to maximize environmental benefits (enhancement/restoration of approximately 8,000-10,000 acres of wetlands) from this project feature. The spreader canal should be positioned as far to the north as possible to maximize this benefit. The Florida DOT originally included provisions for the "spreader canal" in their U. S. Highway 1 widening proposal with the Federal Highways Administration. The spreader canal was to be located at the site of an underpass for the Florida panther, proposed for Mile Marker 122.5. The Department understands that FL DOT is interested in cooperating with the Corps in extending the "spreader canal" under U. S. 1 to the Triangle Lands. Therefore, the Department recommends the Corps continue to investigate opportunities to include this significant ecological restoration component as a project feature.

The adoption of plan 6A may require a relatively small boundary adjustment to Everglades National Park immediately north of the Frog Pond. The National Park Service would support such an adjustment. We feel there is merit in conforming the Park boundary to the western edge of the structures incorporated in the final C-111 GRR. We would like to discuss this possibility with the Corps once final action has occurred on the GRR.

The Department recognizes that the success of the C-111 project will depend on the combination of structural and operational changes that are made and on the process by which operational decisions are implemented. The Department proposes that a three-party agreement between the Corps, Interior (NPS and FWS), and the Local Sponsor be required and used to assure that the new structures are operated to maximize ecological restoration to Everglades National Park and the Triangle Lands, and assure that the project has no adverse impacts on endangered and threatened species in the area. Any operation of the system that causes unnatural hydrological effects (for example, seepage from Park marshes to the east caused by low canal stages, or dumps of fresh water into the estuaries), or that prevents cross-basin transfers of water that may be required to meet restoration requirements (as may be the case with northward pumping of 8.5 sq. mile seepage water) will contribute to long term ecological damage to the Park and related wetlands.

The Department notes no clear distinction between the initial predictions of environmental responses that were conducted as part of the pre-construction planning and the follow-up evaluations and monitoring that occur during and following the construction phase. It is essential that a systematic and comprehensive hydrological and ecological monitoring plan be put in place prior to initial construction. We recommend that, at a minimum, an outline of a monitoring plan, with responsible parties identified, be provided in the Final GRR/EIS for review. Output from hydrological models recently used in the assessment of the C-111 project alternatives have shown hydrological effects as far west as Shark Slough, and it must be assumed that the Modified Water Deliveries project is equally as likely to affect hydropatterns in Taylor Slough and the C-111 basin.

A plan for conducting environmental evaluations of alternative operational plans, and for monitoring environmental responses during and following the construction phases, must be elaborated in more detail during operational planning. Future C-111 project planning documents should show a clear distinction between the predictions of environmental responses among alternative plans, which are developed as part of pre-construction planning, and the follow-up evaluations and monitoring that occur during and following the construction process. It is our view that although the species and community models and other assessment protocols are essential tools for predicting environmental responses during the planning phases of the project, they do not provide definitive measures of these environmental responses. It is essential that a systematic and comprehensive hydrological and ecological monitoring program be put in place prior to the completion of operational plans, and that improvements in design and operational plans be treated as an on-going process, based upon ecological responses detected during regular evaluations of the monitoring data. The Department would like to work closely with the Corps of Engineers to develop and implement the required monitoring program.

The Fish and Wildlife Service has concurred with the Corps of Engineers' December 9, 1993 "no effect" determination for the snail (Everglades) kite, wood stork, bald eagle, Eastern indigo snake, American crocodile, and the Florida panther under Section 7(a)(2) of the Endangered Species Act, for the footprint of the structural changes and operational features thus far evaluated. However, the Service is unable to evaluate effects on the Cape Sable sparrow at this time, except for construction features, and a Biological Opinion may be necessary when operational plans are developed. The Corps of Engineers and other cooperating agencies must soon determine what these operational changes will be, and begin the process of evaluating potential ecological responses to the different operational alternatives.

The Fish and Wildlife Service will submit a Fish and Wildlife Coordination Act Report, fully coordinated with the National Marine Fisheries Service and the State of Florida, upon receipt of the results of the environmental investigations of the National Park Service. In accordance with the Scope of Work between the Corps of Engineers and the National Park Service, these peer reviewed scientific studies will form the basis of the Secretary of the Interior's report to Congress as required by Sec. 2(b) of the Act.

The Department continues to view the C-111 project as an essential step for bringing about ecological restoration in the freshwater marshes and estuaries, including Florida Bay, in Everglades National Park. We remain pleased with the rapid pace in planning for the improvements in the Taylor Slough/C-111 basin.

The staff contact within the Department for questions regarding the Endangered Species Act and the Fish and Wildlife Coordination Act is David Ferrell, Fish and Wildlife Service, Vero Beach, FL (407-562-3909), and for hydrological and ecological issues affecting Everglades National Park is Robert Johnson and John Ogden, respectively, National Park Service, Homestead, FL (305-242-7800).

Thank you for the opportunity to comment on this water resources and ecosystem restoration project. We look forward to continued close coordination throughout all phases of project planning, construction and evaluation.

Sincerely,

James H. Lee

James H. Lee
Regional Environmental Officer

CC: FWS, RO, ATL
NPS, RO, ATL
Everglades NP, FL
FWS, Vero Beach, FL
FWS, Jacksonville, FL
USGS, Tallahassee, FL
NBS, Gainesville, FL
OEPC, Washington. DC

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Affairs
Richard B. Russell Federal Building
75 Spring Street, S.W.
Atlanta, Georgia 30303

February 3, 1994

ER-94/15

Mr. A. J. Salem
Chief, Planning Division
Jacksonville District
U. S. Army Corps of Engineers
P. O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Salem:

This letter provides the combined comments of the Agencies of the U. S. Department of the Interior on the Preliminary Draft of the "Integrated General Reevaluation Report and the Environmental Impact Statement" for the Canal 111 (C-111) Project, submitted to the Department by letter dated December 22, 1993.

The Department's last response on the C-111 project was in 1988, when the Jacksonville District issued a Draft General Design Memorandum and Environmental Impact Statement. The C-111 project at that time was primarily designedfor agricultural flood damage reduction, prevention of damaging flows to Barnes Sound/Manatee Bay, and increased water flows to the park's panhandle. The report did not address restoration of Taylor Slough because the basin's problems had not been fully defined.

The Department is pleased and fully supports the current project purpose to eliminate these damaging fresh water releases, and to begin the ecological restoration of Taylor Slough, the C-111 basin, the U.S. Highway One/Card Sound triangle and eastern Florida Bay. And as now proposed, the project would greatly assist in the overall larger issue of ecosystem restoration of the Everglades.

The Department understands that the Corps' planning schedule must be expedited so that a report can be released for public comment in February, 1994. We support this expedited process, and offer the following comments to assist in future project planning, and to insure that the project will provide the maximum level of ecological restoration for this region.

We are encouraged that several of the alternative plans, specifically numbers 4 and 6, and the National Park Service's number 8, contain structural requirements with the potential to produce favorable environmental results, by spreading water throughout the C-111 basin and by creating a hydrological transition zone between areas that must be managed as natural wetlands and the eastern developed areas.

Of these three alternative plans, the Department considers that plan 8 has by far the greatest potential for meeting the ecosystem restoration goals for the region in question, including the full length of Taylor Slough and eastern Florida Bay. Only plan 8 combines the structural features of (1) a transition zone of water detention/retention areas along the L-31N and L-31W alignments, (2) a series of relatively small capacity pumps along L-31N for spreading water across the Taylor Slough headwaters, and (3) the elimination of C-109, C-110 and C-111 below C-111E. The creation of a hydrological transition zone, to provide transition of water levels from high stages in the Everglades to lower stages in the eastern developed areas, may be essential for meeting the restoration objectives set for eastern Everglades National Park including eastern Florida Bay. The Department also suggests that the elimination of lower C-111 will require a 500 cfs pump at the western end of the proposed East-West Spreader Canal at C-111E.

Additional information on the characteristics of the proposed plan 8 are contained in the technical report from Everglades National Park, SFNRC 93-4, submitted to the Corps of Engineers as part of the Park's evaluation of alternative plans 1 through 7. Because this NPS report contains an important assessment of hydrological alternatives 1-7, and it proposes an improved plan (number 8) the Department requests that it be cited as a supporting reference to these comments in the February, 1994, revision of the draft C-111 report.

Important features of plan 8 include structural and operational modifications outside of the study area of the C-111 project, and within the region of the Modified Water Deliveries to Everglades National Park project. Because ecological restoration in both of these areas may require cross basin water transfers, and an integrated plan of operations, the Department requests that the Corps take the lead in creating an inter-agency team to address issues associated with the integrated management of these two projects.

The success of Plan 8, or any other structural plan, will depend on the development of revised operational criteria for the northeast Shark Slough, Taylor Slough and C-111 basins. For example, the National Park Service's hydrological assessment of the alternative plans shows that plans 2 through 6 lower wet season water levels in the L-31N canal, and throughout much of the eastern developed areas, to levels well below those predicted for the base condition. Water budget computations indicate that this practice leads to continued over-drainage of the Rocky Glades and northern Taylor Slough wetlands, which in turn reduces the volume of water that can flow naturally into the lower Taylor Slough and Florida Bay systems. Low wet season water levels in the L-31N, C-111, and coastal canals also cause massive seepage losses to the east.

These changes in the structural capacities and canal design conditions must proceed without delay. Significant changes in operational policies must follow to assure success. Larger pump capacities must be balanced by increases in normal canal operational stages in order to avoid drainage beyond the authorized levels of flood protection, and risk increased damage to natural resources in the Taylor Slough and eastern Florida Bay regions. Increased canal operational stages will allow more of the wet season runoff to be stored in the adjacent aquifer, which will reduce dry season supplemental demands. Higher wet season canal stages also reduce seepage losses from the wetlands, which provides for higher water levels in the adjacent marshes and helps to create the hydrological gradient necessary for moving sheet flow into the estuaries.

The success of the C-111 project will depend on the combination of structural **and** operational changes that are made, and on the process by which operational decisions are made. The Department proposes that a three-party agreement process be required and used to assure that the new structures are operated to maximize ecological restoration to the Park and other natural wetlands in the region. We should not build or operate a system that can increase flood protection east of the Park if that increased protection causes any ecological damage to the Park or to other regional wetlands (for example, seepage from Park marshes to the east caused by low canal stages; dumps of fresh water into the estuaries), or that prevents cross basin transfers of water that may be required to meet restoration requirements (as may be the case with northward pumping of 8 1/2 sq. mile seepage water).

An intensive ecological and hydrological assessment of a range of alternative operational criteria will be evaluated by the National Park Service during 1994, as part of the C-111 project planning process. We should expect to propose possible structural refinements and the development of an initial set of operational criteria based upon the results of these assessments. The Department further suggests that we must be able to continue to refine operational criteria for the L-31 and C-111 systems as our ecological understanding of the region improves. An iterative process based on a three party agreement will allow operational criteria to evolve as our knowledge improves.

The Fish and Wildlife Service will provide specific recommendations on this project in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 S.S.C. 661 et seq.) and Section (7) (a) (2) of the Endangered Species Act, as amended (16 U.S.C. 1531 et seq.) in their Fish And Wildlife Coordination Act report anticipated to be completed this spring. The Fish and Wildlife Service concurs with the Corps of Engineers' December 9, 1992 "no effect" determination for the snail (Everglades) kite, wood stork, bald eagle, Eastern indigo snake, American crocodile, and the Florida panther under Section 7(a) (2) of the Endangered Species Act at this time. While the Fish and Wildlife Service anticipates minimal effects on the Cape Sable sparrow, a Biological Opinion may be required when operational plans are developed in the future.

The Department notes that the preliminary GRR/EIS lacks an ecological monitoring plan. We recommend that, at a minimum, an outline of a monitoring plan, with responsible parties, be provided in the Draft GRR/EIS for review.

Everglades National Park has been assigned the lead responsibility to coordinate the preparation of comments for the Department of Interior. Please do not hesitate to contact the park with any questions regarding these comments.

Thank you for the opportunity to comment on this water resources and ecosystem restoration project. We look forward to continued close coordination as project plans progress.

Sincerely,

James H. Lee

JAMES H. LEE
Regional Environmental Officer

cc: Bill Ott
Bureau of Indian Affairs
370l N. Fairfax Dr
Arlington, VA 22201

Richard G. Ring, Superintendent
Everglades National Park
4000l SR 9336
Homestead, FL 33034

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U.S.Geological Survey
227 North Bronough St, Suite 3015
Tallahassee, FL 32301

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National Biological Survey
7920 NW 71st St
Gainesville, FL 32606

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U.S. Fish & Wildlife Service
6620 Southpoint Dr South, Suite 310
Jacksonville, FL 32216

United States Department of the Interior

FISH AND WILDLIFE SERVICE
P.O. BOX 2676
VERO BEACH, FLORIDA 32961-2676

January 19, 1994

Colonel Terrence C. Salt
District Engineer
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Attn: Planning Division RE: C-111

Dear Colonel Salt:

The U.S. Fish and Wildlife Service (Service) has preliminarily reviewed the alternative project plans for the revised Canal-111 project as part of the Central and Southern Florida Flood Control Project. We are aware of the progress made thus far on this renewed study. This report is submitted in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

We have had a representative working with the Environmental Evaluation Team for the C-111 for the past several months. The Team is composed of representatives from the Corps of Engineers, Fish and Wildlife Service, National Park Service, Florida Game and Freshwater Fish Commission, National Audubon Society, and the local sponsor, the South Florida Water Management District.

While we would normally review Federal projects after completion of environmental studies and as operational plans were being finalized, we concur with the evaluation methodology employed for this study. These methods are based on previous biological research results undertaken in Everglades National Park.

Several of the alternatives presented in the latest Corps of Engineers plans (alternatives 3 through 6) are consistent with the original environmental objectives the Service has for this project, specifically:

1) reduce freshwater discharges to Barnes Sound as much as possible;

2) establish sheetflow across the marshes from the area south of Florida City southward across C-111 and the panhandle of Everglades National Park to Florida Bay; and,

3) restore or augment flows to northeast Florida Bay by delivering water to Taylor Slough in Everglades National Park.

We appreciate the incorporation of the Service's proposal to place a "spreader canal" at the north end of "triangle" basin for flow dispersion. We also support National Park Service efforts to raise water levels in the Context Road area of the East Everglades.

While we have not made a determination on the effects of these alternatives on the endangered Cape Sable sparrow, preliminary results indicate that any changes to that endangered species' habitat are likely to be minimal. This could change if other sources of water were directed to Taylor Slough.

We would be pleased to consider any other design options, but believe several of the alternative plans presented could achieve our original environmental objectives. These alternatives will be further evaluated by the Service as they are further refined and as operational plans using more refined modeling results become available. Our final recommendations will be presented in a Fish and Wildlife Coordination Act report later this Spring.

We hope this letter satisfies your current needs pending completion of our Fish and Wildlife Coordination Report on this project. If you have further questions on this matter, please contact Joseph D. Carroll of my staff (407-562-3909).

Sincerely yours,

David L. Ferrell

David L. Ferrell
Field Supervisor

ANNEX E

C-111

CULTURAL RESOURCES COORDINATION

FLORIDA DEPARTMENT OF STATE
Jim Smith
Secretary of State
DIVISION OF HISTORICAL RESOURCES
R.A. Gray Building
500 South Bronough
Tallahassee, Florida 32399-0250
Director's Office (904) 488-1480
Telecopier Number (FAX) (904) 488-3353

January 20, 1994

Ms. Janice L. Hatter, Director
State Clearinghouse
Executive Office of the Governor
Room 1603, The Capitol
Tallahassee, Florida 32399-0001

In Reply Refer To:
Denise M. Breit
Historic Sites Specialist
(904) 487-2333
Project File No. 940057

RE: Cultural Resource Assessment Request
SAI# FL9401051559C
Central and Southern Florida Project - Preliminary Draft: Integrated General Reevaluation Report and Environmental Impact Statement - Canal 111 (C-111)
Dade County, Florida

Dear Ms. Hatter:

In accordance with the provisions of Florida's Coastal Zone Management Act and Chapter 267, Florida Statutes, as well as the procedures contained in 36 C.F.R., Part 800 ("Protection of Historic Properties"), we have reviewed the referenced project(s) for possible impact to historic properties listed, or eligible for listing, in the National Register of Historic Places, or otherwise of historical or architectural value.

A review of the Florida Site File indicated that there are several tree islands in the general vicinity of the project area. It is the recommendation of this office that if the tree islands will be impacted by any construction activities (i.e., new canals, pump stations, detention pools, etc.), they should be subjected to a systematic, professional archaeological survey prior to the commencement of such activities. In addition, changes in the water volumes and levels should be monitored to determine if any tree islands or oak hammocks are being affected by the flooding. If it is evident at this time or becomes evident in the future that the referenced topographical features will be impacted, they should be subjected to a survey such as that described above. The purpose of these surveys will be to locate and assess the significance of historic properties present. The resultant survey report must be forwarded to this agency in order to complete the process of reviewing the impact of this proposed project on historic properties. We note that the above stipulations are cited in the project document.

ANNEX F

C-111

EVERGLADES NATIONAL PARK

DRAFT
ENVIRONMENTAL EVALUATION FOR THE STRUCTURAL ALTERNATIVE PLANS FOR THE C-111 DRAFT GRR

SUBMITTED TO THE U.S. ARMY CORPS OF ENGINEERS

United States Department of the Interior

NATIONAL PARK SERVICE
Everglades National Park
and
Dry Tortugas National Park
40001 State Road 9336
Homestead, Florida 33034-6733

IN REPLY REFER TO:
L54

Colonel Terrence C. Salt
District Engineer
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Colonel Salt:

I am writing this letter to transmit the enclosed follow-up materials that your staff had requested at the PRC meeting in early February, in support of the Draft C-111 General Reevaluation Report. I have also included the Park's general comments on the recently added Alternative 6A, as requested in your February 14, 1994 fax transmission. The first document includes a summary of the natural features of the C-111 study area, a brief discussion of past water management problems, and the justification for our focus on re-establishing more natural hydrologic conditions in the Park, and specifically in the Rocky Glades. The second document is an appendix to our previously transmitted technical report (93-4), which presents the results of our more detailed assessment of the hydroperiod and water level changes in seven subbasins of the study area. The subbasin analysis using the results of the SFWMD's 1x1 model shows improvement in the hydrologic conditions in the Rocky Glades area under both Alternatives 4 and 6. We have also provided a more detailed description of the structural plan that we envisioned for proposed Alternative 8, and a comparison of this alternative and 6A.

The structural components for Alternative 6A are similar to the Park's proposed plan for northern Taylor Slough and the Rocky Glades, and should provide the potential for significant improvements in water deliveries in these areas of the Park. While there are still substantial differences in the areas of the Frog Pond and the lower C-111 basin, we believe that all of the major components necessary for a workable plan have been reviewed with your staff. The Park strongly supports moving forward immediately into the public review process. We remain committed to working with your staff in the next phase of detailed planning, and anticipate that the remaining issues can be resolved, including the development of operational criteria for the project.

Sincerely,

Richard G. Ring
Superintendent

The Natural Features of the C-111 Study Area

Figure 1 is a map of the natural physiographic features of the C-111 basin and the eastern portion of Everglades National Park. The generalized land units are taken from a soil association map prepared by the University of Florida and the USDA (Leighty et al. 1954), and are used here to define the landscape characteristics of the study area. An excellent summary of the physiographic features of the lower Everglades, Florida Bay, and the Florida Keys is presented in a U.S. Fish and Wildlife Service report prepared in 1982 (Schromer and Drew 1982). The soil descriptions indicate that under natural conditions essentially all of this area, except the higher elevated Atlantic Coastal Ridge, was subjected to seasonal flooding due to low ground surface elevations and the close proximity to the Everglades. At Tamiami Trail, the concave depression that shaped the "River of Grass" is constricted, forming a narrow southwesterly trending arc of continuous wetlands which define the Shark Slough drainage. Shark Slough represents the southern extension of the Everglades trough, which originates outside of the Park in the wetlands of Water Conservation Area 3B. To the northwest of Shark Slough, the bedrock of the Everglades rises gradually into the sandy marl prairies of the Big Cypress basin. This area extends well south of Tamiami Trail, forming the transitional and short hydroperiod marshes to the west of the L-67 extension canal. These marl prairies occur on slightly higher bedrock elevations, and were originally only seasonally inundated. Today they are substantially wetter due to the diversion of flows away from the Northeast Shark Slough flow-way and into western Shark Slough.

To the southeast of Shark Slough is a large area of transitional (less than 3 months hydroperiod) and short hydroperiod (3 to 5 months hydroperiod) wetlands referred to as the Rocky Glades. Maximum inundations occurred after the peak of the rainy season, and formed a natural buffer separating the deeper Everglades marshes from the higher elevated, and drier areas along the Coastal Ridge. During the wet season, the Rocky Glades would receive runoff from the western portion of the Coastal Ridge, while additional surface water would spill over from the expanding Shark Slough wetlands. The shallow soils and exposed limestone bedrock in the Rocky Glades make it an important area of direct recharge to the underlying aquifer, which supplies groundwater flows to the adjacent eastern developed areas as well as the downstream Everglades. The Rocky Glades are significant hydrologically, since the southern portion of this area drains to the southeast, where it forms the headwaters of the Taylor Slough watershed. The marl soils in upper Taylor Slough extend eastward, covering much of the Frog Pond, and northward along the western flank of the Coastal Ridge. Under natural conditions, this region captured wet season runoff from the western Coastal Ridge and directed it westward into Taylor Slough, where it would be slowly released into the downstream marshes and Florida Bay. Construction of the L-31N, C-111, and L-31W levees has isolated much of the historical contributing area to Taylor Slough, and excess wet season runoff from this region is now rapidly drained via the canal systems eastward to Biscayne Bay or

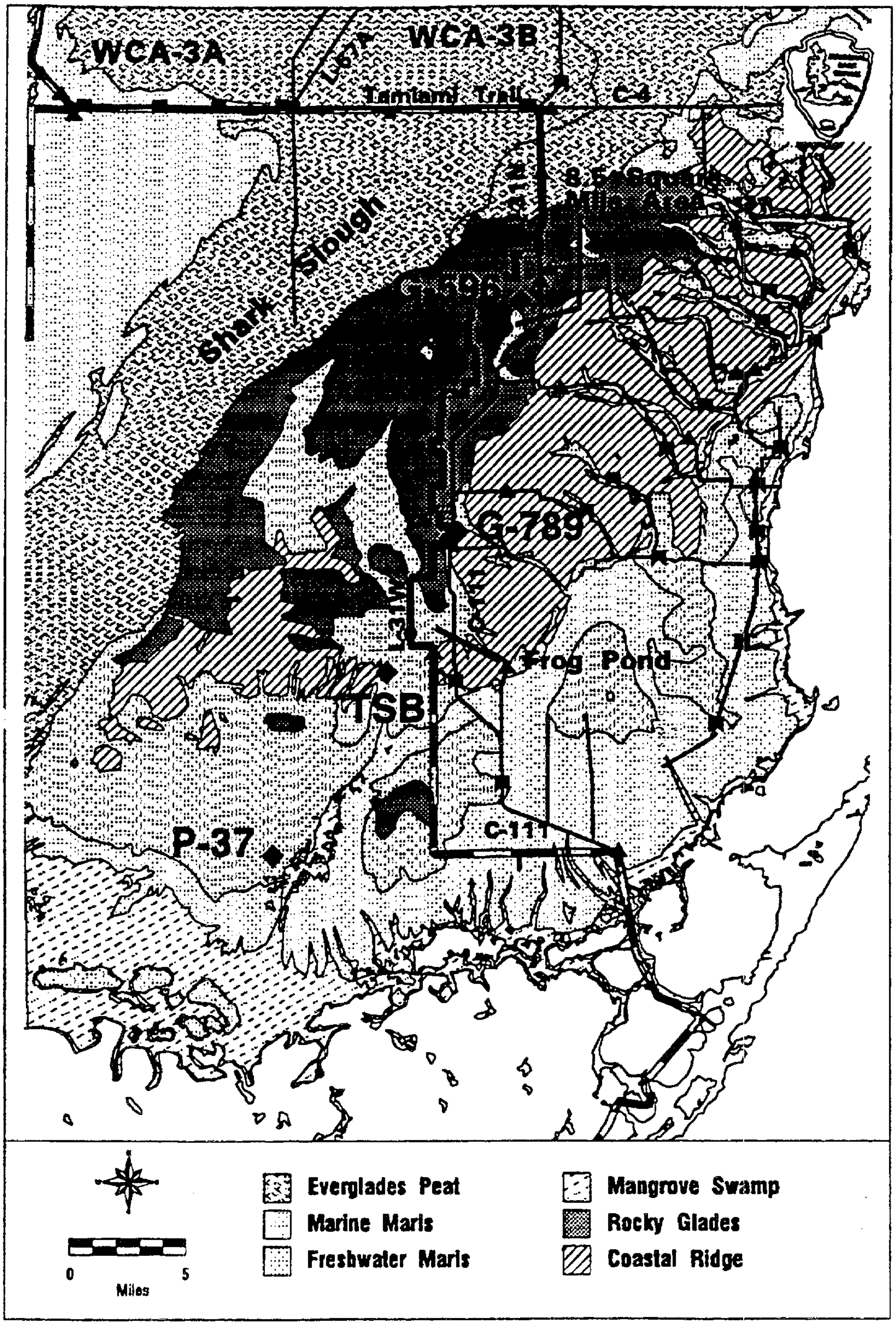


Figure 1. Map of the Natural Physiographic Features in the C-111 Study Area.

southward into the lower C-111 basin. These changes are a major reason for the long-standing conflicts over water management in this area and continue to contribute to the drainage problems in the eastern wetlands within Everglades National Park.

The lower C-111 or Eastern Panhandle basin is part of the Southeast Coastal Glades, which are underlain by a mixture of freshwater marls in the areas adjacent to the Coastal Ridge. Near the coast, these freshwater marls transition into marine marls (Leighty et al. 1954). Under natural conditions, the lower C-111 basin received the bulk of its runoff from the southern portion of the Atlantic Coastal Ridge. These surface and groundwater flows constitute the primary source of freshwater inflows to the northeastern portion of Florida Bay. Today much of the southern Coastal Ridge has been developed, and a significant portion of this natural runoff has been diverted eastward into Biscayne Bay. In the mid 1960's, when the C-111 canal was constructed, it formed a breach between the Coastal Ridge and the marl prairies. This has allowed wet season runoff from northern Taylor Slough (and at times runoff from Northeast Shark Slough) to be transferred into the lower C-111 basin. At the same time the natural marsh sheetflow was altered by the lower C-111 levees impounding water to the north of the canal which led to overdrainage of the marshes south of the canal. The southward diversion of runoff from the areas north of the Frog Pond increased freshwater inflows into the lower C-111 marshes and downstream Florida Bay during the 1980's, but the source of most of this water is drainage of the upstream wetlands (Northeast Shark Slough and the Rocky Glades) within the Park. Thus, the water draining from these areas is transferred through the canal system and re-introduced into the wetlands at a lower point. Recent acquisition by the State of a large tract of the marsh lands north of the lower C-111 basin has led to increased pressure to reintroduce surface water inflows as far north as possible. This has the benefits of maximizing natural marsh sheetflow, and mitigating damaging freshwater releases into the downstream estuaries during periods of high wet season runoff.

Past Hydrologic Changes in Southwestern Dade County

The earliest C&SF Project construction in southwestern Dade County began in 1951, with the completion of the L-30 levee and the northern portion of the L-31N levee. These levees were originally built as part of the Eastern Protective Levee System, to protect the expanding developed areas of the Lower East Coast from Everglades flooding. This levee system also established the land use plan for western Dade County, by defining the limit of flood protection. The original plan of improvement for southwestern Dade County also anticipated that the majority of the low-lying areas east of the L-31N and C-111 levees and adjacent to the Everglades would be developed for seasonal agriculture (U.S. Army Corps of Engineers 1961). This plan called for gravity drainage of an area of 227 square miles of southwestern Dade County using a system of 12 primary canals.

Although the Corps recognized that the natural drainage in the western portion of the Coastal Ridge was to the southwest (into Taylor Slough), gravity drainage primarily to the east and south (into Biscayne Bay, Barnes Sound, and Florida Bay) was found to be most practical, particularly with the continuing pattern of declining groundwater levels in the Coastal Ridge.

Runoff from the east of L-31N and north of Homestead was to be drained eastward into Biscayne Bay via six proposed canals (C-101 through C-106). The area south of Homestead was to be drained southward into Florida Bay and Barnes Sound via six proposed canals (C-107 through C-112). During project review, the National Park Service wrote correspondence to the Corps concurring with the plan for eastern Dade County, but requested that the area west and northwest of Homestead be drained westerly into Taylor Slough, to reduce the drainage effects of the C&SF Project improvements. The National Park Service and the Fish and Wildlife Service also objected to the southerly extension of the proposed C-109, C-110, C-111, and C-112 canals to tidewater, and requested that the canals be terminated at the one-foot contour to promote sheetflow, and reduce the effects of direct freshwater inflows to the downstream estuaries.

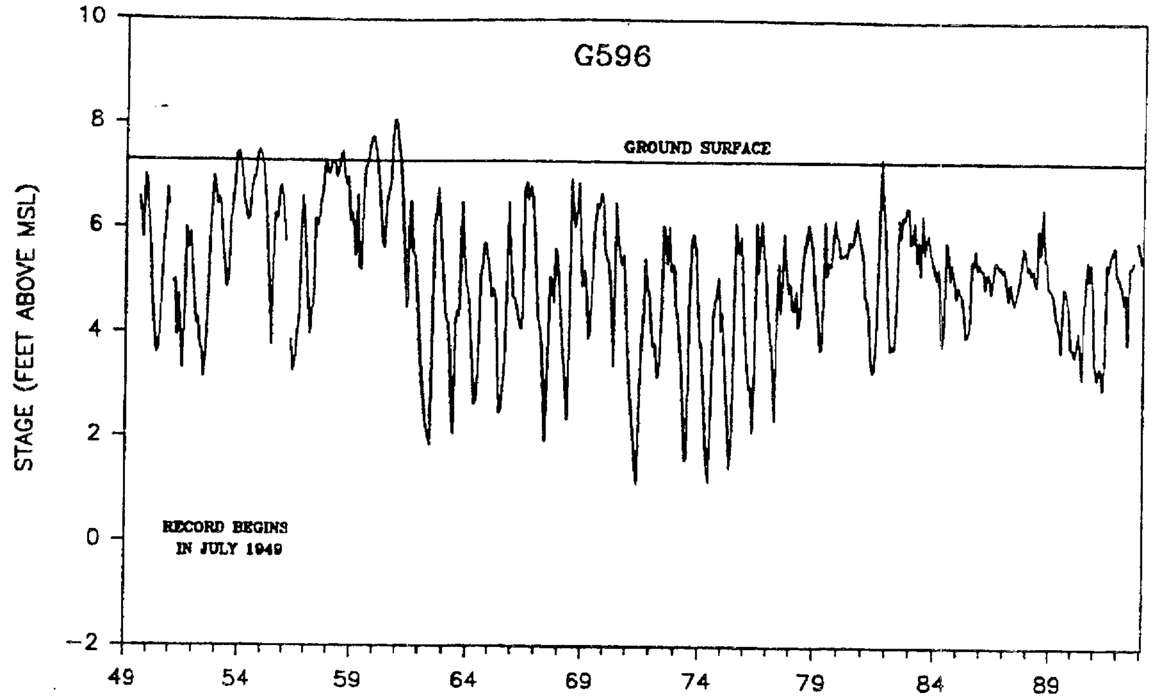
The 1961 plan was modified in the South Dade County GDM (U.S. Army Corps of Engineers 1963) so that the L-31N canal would be used "to provide southerly drainage to ENP in Taylor Slough for the westerly portion of south Dade County". The L-31W canal was specifically added as part of the 1963 GDM so that during the design storm approximately 28 square miles of land adjacent to the C-102 and C-103 canals would be drained westward into Taylor Slough. The first proposed operating criteria for the southern reach of the L-31N canal would have allowed wet season canal stages to rise as high as 6.5 feet to promote the discharge of water into Taylor Slough via the L-31W canal. Water would then spill overbank from the L-31W canal into Taylor Slough. Under flood conditions, up to 500 cfs would be discharged into the L-31W canal and pass southward via S-175, to maximize Taylor Slough inflows.

Prior to construction of the C&SF Project the farming practices in this region had adapted to the natural cycle of Everglades flooding and drying. Land preparation and planting would begin after wet season water levels naturally receded. Agricultural practices were thus in tune with the natural variability in seasonal rainfall and water levels. By the late 1960's and early 1970's, construction of the L-31N, L-31W, and C-111 canal systems reached completion, and the optimum canal operational stages were lowered in response to expanding agricultural and urban development into the lower-lying areas of western Dade County (Van Lent et al. 1993). During the 1980's, agricultural practices in the region began to change, in part due to a lower than normal decade of rainfall. Grove crops, which require low ground water levels throughout the year, expanded into the western portions of the basin. In addition, economic pressures forced south Dade farmers to plant their row crops earlier in the season to compete with growers from other areas. Both of these changes prompted additional demands to lower canal operational stages to increase groundwater storage potential so there would be a readily available area to absorb the stormwater runoff, thereby reducing the risk of flooding of the root zones.

The operational levels maintained in the L-31N, L-31W, and C-111 canals are also extremely important to the natural areas in the eastern section of the Park. These canals traverse the Rocky Glades and canal water levels largely control the magnitude of groundwater losses from the Northeast Shark Slough and Taylor Slough basins. The underlying limestone of the Rocky Glades is the most permeable bedrock found in South Florida, and minor reductions in canal water levels drain tremendous quantities of surface and ground water from the wetlands. Maintenance of higher surface and ground water levels in this area is pivotal to the restoration of flows throughout Northeast Shark Slough, Taylor Slough, and into the downstream estuaries of the Gulf of Mexico and Florida Bay. The immediate loss of stormwater runoff to tide during the rainy season and the continued drainage of the wetlands and stored groundwater into the dry season not only cause the loss of natural hydroperiods in the uplands, but also cause a drastic reduction of freshwater flow into the downstream estuaries during the remainder of the dry season. The resulting reduction in groundwater levels further aggravate the problem when the early spring rains arrive, rainfall must first fill up the depleted groundwater regime before surface water flow can resume, and transport freshwater into the downstream marshes and estuaries.

The Impacts of Water Management in the Rocky Glades

The impacts of water management changes in the Rocky Glades most likely date back to the beginning of drainage activities in the Everglades watershed. Unfortunately, little hydrologic information exists for the pre-drainage Everglades. Figure 2 shows water level hydrographs for two long-term monitoring stations in the Rocky Glades, which were installed in the late 1940's and mid 1950's (see Figure 1 for locations). Even with this late start, the plots indicate that the transitional wetlands in these areas were routinely subjected to short periods of seasonal flooding until approximately 1962, when the L-29 levee was completed, enclosing WCA 3B. Table 1 provides a brief summary of the water level and hydroperiod changes that have occurred in the Rocky Glades area. Prior to 1962, average wet season water levels exceeded 6.9 feet at the G596 gage, and exceeded 5.80 feet at the G789 gage. After 1962, average October water levels dropped by 1.2 to 1.5 feet at these gages. Similar reductions have occurred in average water levels during the late dry season. The reduced water levels have had a profound affect on hydroperiods in the Rocky Glades. Prior to 1962, surface water inundations occurred on average, 13 to 14 percent of the time. After 1962, surface water inundations occurred less than 1 percent of the time. More importantly, groundwater levels have become so low that much of the Rocky Glades has water levels several feet below the ground surface throughout the year. Under these conditions, rainfall rarely raises water levels to the point where



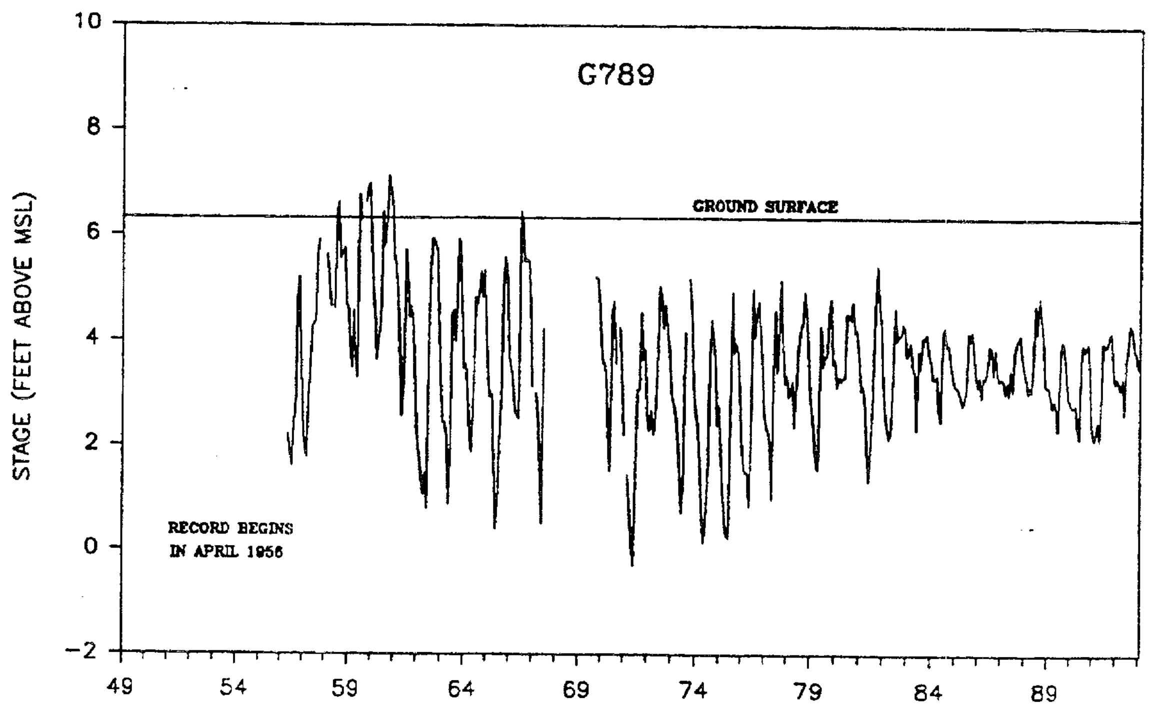


Figure 2. Water Level Hydrographs for two Long-Term Monitoring Stations in the Rocky Glades (see Figure 1 for site locations).

Table 1. Brief Summary of the Water Level and Hydroperiod Changes in the Rocky Glades. Key Stages are 6.0 feet at G596 and 5.0 feet at G789.

	PRE-1962		POST-1962	
SITE NAME	AVERAGE OCTOBER WATER LEVEL	AVERAGE APRIL WATER LEVEL	AVERAGE OCTOBER WATER LEVEL	AVERAGE APRIL WATER LEVEL
G596	6.93	4.96	5.71	3.47
G789	5.82	3.22	4.35	2.03
SITE NAME	PERCENT GREATER THAN KEY STAGE	PERCENT GREATER THAN GROUND SURFACE	PERCENT GREATER THAN KEY STAGE	PERCENT GREATER THAN GROUND SURFACE
G596	57	13	11	<1
G789	41	14	7	<1

surface water flows are produced, so the Rocky Glades have lost much of their ability to contribute flows to the Taylor Slough watershed, except under extreme rainfall events.

Wet season water levels show a further reduction in the early 1970's. The reduced water levels in the 1970's are thought to be a primary factor responsible for the increased agricultural and residential development throughout the low-lying areas of western Dade County. This has even allowed development to expand into the unprotected areas west of the Eastern Protective Levee System. This area remained relatively dry throughout the 1970's, as a result of a long period of lower than normal rainfall, the continued diversion of sheetflow away from NESS, and slightly improved drainage from the adjacent canals to the east. In spite of this, the agricultural and urban areas west of the L-31N canal are extremely susceptible to flooding, since the C&SF Project has no project features or provisions to provide flood protection in these areas.

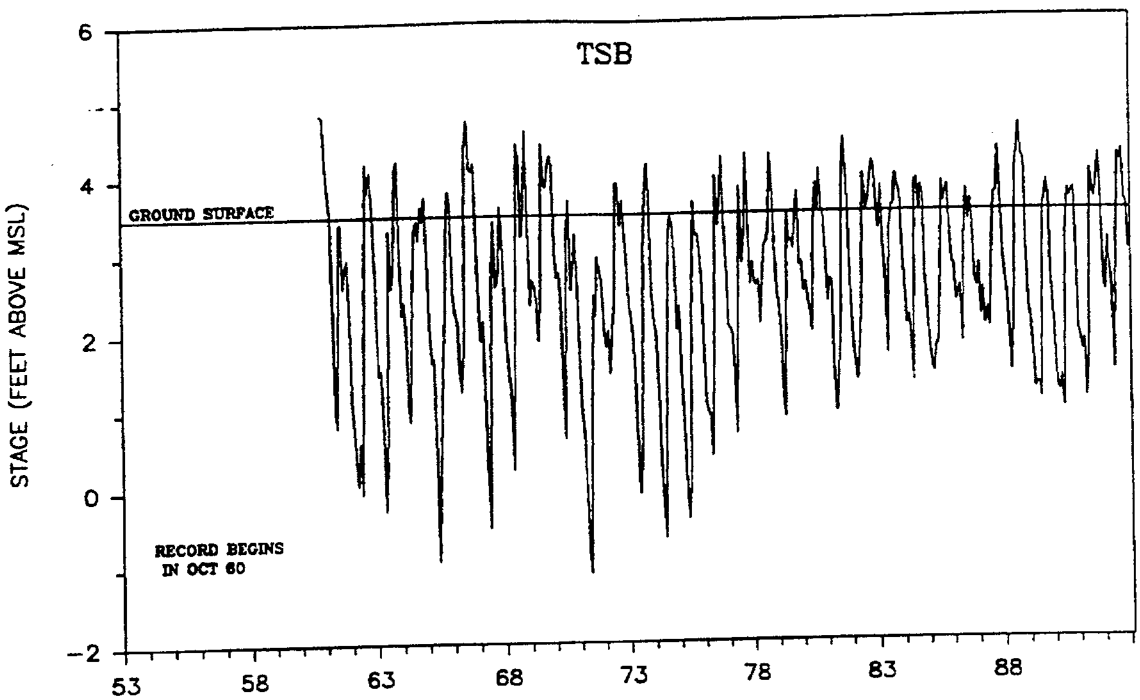
In August and September of 1981, two extreme rainfall events produced extensive flooding in western Dade County. The unprotected areas of the East Everglades experienced surface water flooding for a period of several weeks. In June 1982, water levels in the adjacent L-31N canal were lowered, in an attempt to provide flood protection to the developed areas west of the L-31N canal. In mid 1983, after a period of high rainfall and continued flooding, the SFWMD began using the S-331 pump station to lower L-31N canal water levels to provide additional flood protection to the East Everglades Residential Area (8.5 Square Mile Area). This pump station was built as part of the South Dade Conveyance System, and was designed only for dry season water supply pumping. The SFWMD and the NPS have completed several hydrologic studies which show that the use of this pump station for flood protection has led to overdrainage of the Northeast Shark Slough wetlands, and may contribute to the flooding problems in the Rocky Glades agricultural area and the Frog Pond. In 1984, the Army Corps of Engineers, the SFWMD, and the NPS began a program of re-introducing surface water flows into the Northeast Shark Slough basin. As part of this program, the L-31N canal was further lowered, and strict operating criteria were established to limit NESS inflows during periods when the groundwater levels in the East Everglades are high. Hydrologic studies by the Corps, the SFWMD, and ENP have shown that throughout the NESS test, water levels in the East Everglades have remained below the pre-test levels. Even with these changes, the area remains subject to high groundwater levels and periodic flooding during extreme rainfall periods, because of low ground surface elevations, and its close proximity to the Everglades.

The Impacts of Water Management in Taylor Slough

Water level monitoring stations in the Taylor Slough basin were also installed well after the start of drainage activities in the Everglades. Figure 3 shows water level hydrographs for two long-term monitoring station in the Taylor Slough basin. The earliest monitoring data for the upper Taylor Slough area began at the bridge over Taylor Slough in late 1960. Monitoring began in the lower Taylor Slough area in early 1953. Table 2 provides a brief summary of the water level and hydroperiod changes at these two monitoring sites. The comparison in table 2 breaks the record based on the start of construction of the L-31N and C-111 canals in early 1965. Note that average wet season water levels at Taylor Slough Bridge and at P-37 show very little change. During the late dry season, water levels at the Taylor Slough Bridge have increased, as a result of supplemental water deliveries from the SDCS. Station P-37 shows no apparent water level or hydroperiod changes because it is located in the lower portion of the watershed, and the effects of local rainfall and its close proximatey to tide, overshadow the impacts of upstream water management.

Restoration Goals for the Rocky Glades and Taylor Slough

The wetlands throughout the Rocky Glades and Taylor Slough have experienced major changes in their original patterns of seasonal flooding and sequential drying as a result of reduced surface water inflows, the redirection of stormwater runoff to the eastern coastal canals, and the drainage effects of the canal system along the Park's eastern boundary. These hydrologic alterations have subsequently led to a reduction in the spatial scale of these wetlands, a loss of habitat heterogeneity, and declines in ecosystem productivity, that can be seen in many of the key plant and animal communities within the Park and adjacent natural areas. The current plan by the Army Corps of Engineers for Modified Water Deliveries to Everglades National Park is designed to address many of these



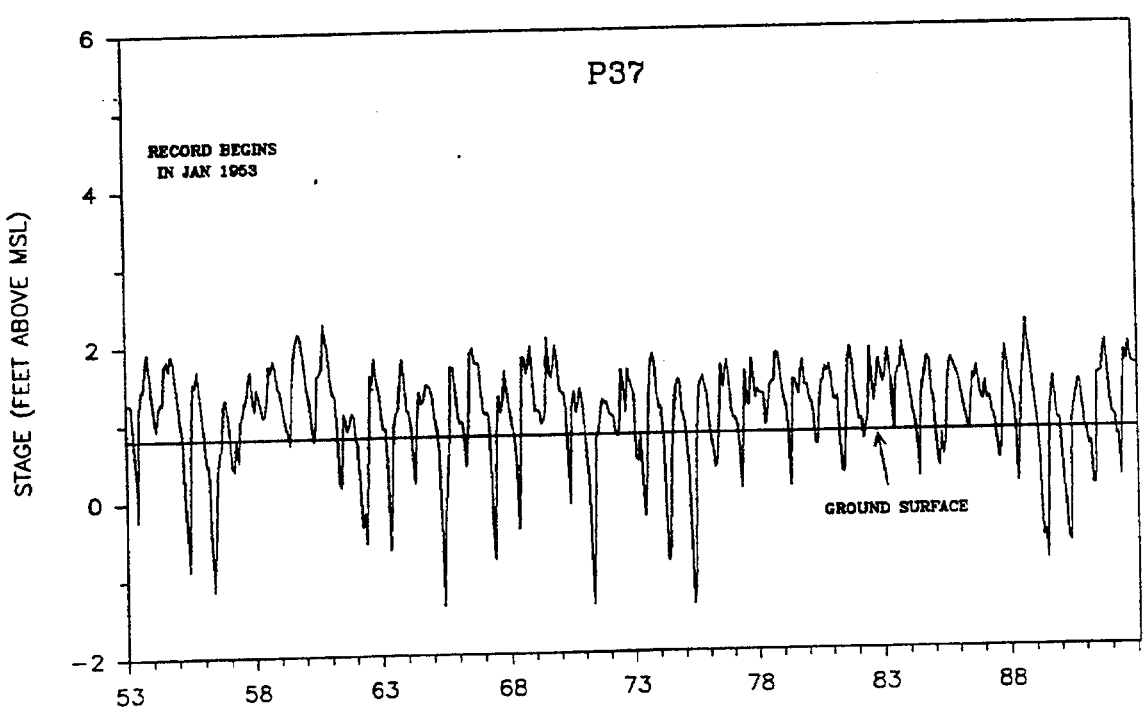


Figure 3. Water Level Hydrographs for two Long-Term Monitoring Stations in the Taylor Slough Basin (see Figure 1 for site locations).

Table 2. Brief Summary of the Water Level and Hydroperiod Changes in the Taylor Slough Basin. Key Stages are 3.0 feet at TSB and 0.8 feet at P-37.

	PRE-1965		POST-1965	
SITE NAME	AVERAGE OCTOBER WATER LEVEL	AVERAGE APRIL WATER LEVEL	AVERAGE OCTOBER WATER LEVEL	AVERAGE APRIL WATER LEVEL
TSB	3.83	0.54	3.71	1.24
P-37	1.67	0.24	1.62	0.25
SITE NAME	PERCENT GREATER THAN KEY STAGE	PERCENT GREATER THAN GROUND SURFACE	PERCENT GREATER THAN KEY STAGE	PERCENT GREATER THAN GROUND SURFACE
TSB	41	24	41	28
P-37	76	76	74	74

concerns through the re-introduction of sheetflow, and restoration of more natural water depths and hydroperiods in Northeast Shark Slough. This effort to re-establish higher surface water levels and longer hydroperiods in the deeper slough is crucial to increasing ecosystem productivity and maintaining adequate freshwater flows to the west coast estuaries, but these changes alone will not restore natural ecological function. Restoring more natural hydrologic conditions in the transitional wetlands of the Rocky Glades is also an essential component of this ecosystem restoration program. Without simultaneously raising groundwater levels and reinstating the historical seasonal inundations in the higher elevated prairies of the Rocky Glades, we will loose a key component of the natural diversity of habitats that are needed to sustain the wide range of animal species adapted to the natural Everglades Ecosystem.

Everglades National Park has developed a water management policy for Taylor Slough and the Rocky Glades that focuses on meeting a set of water level targets for the marshes in the northern portion of the Taylor Slough watershed. These weekly "average" water levels are based on their best estimate of the hydrology of the watershed in the 1930's and 1940's when the Park was established (Van Lent and Johnson 1993). The water level targets were designed to vary seasonally and annually in response to local rainfall, such that for any given week, half of the years will have water levels higher than this target, and half of the years will have water levels lower than the target. The weekly water level targets are calculated using an impulse response function, that is the mathematical relationship between rainfall and the average weekly stage for the period from 1933 through 1947. The plan would be implemented by adding up, or superimposing, the effects of all of the rainfall events over the previous 52 weeks,

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ENVIRONMENTAL EVALUATION FOR THE STRUCTURAL ALTERNATIVE PLANS FOR THE C-111 DRAFT GRR, SUBMITTED TO THE U.S. ARMY CORPS OF ENGINEERS, DECEMBER 1993

John C. Ogden, William B. Robertson, Jr., Joe Carroll, Janet Ley, G. Thomas Bancroft, and Gerald Atmar

INTRODUCTION

This report provides a description of the process, and the results, from an effort to evaluate the environmental responses in the Taylor Slough and C-111 basins, and in eastern Florida Bay, to six proposed, alternative plans for structural modifications to the C-111, L-31N and L-31W water delivery systems.

ECOLOGICAL DEGRADATION OF THE TAYLOR SLOUGH AND C-111 BASINS

Although the timing and overall quantitative aspects of the biological degradation of the Taylor Slough/C-111 basins is poorly documented, it is well known that the region once maintained highly important wildlife habitat. We know, for example, that as recently as the 1940s and 1950s, Grossman's Slough (southwest of Grossman's Ridge) still supported a large, reproductively active population of American Alligators (G. Simmons, pers. observations). We also know that other sloughs in the headwaters east of Grossman's Ridge, including sloughs inside the present "8 1/2 sq. mile residential area", were important habitats for large numbers of migratory and wintering waterfowl and wading birds as recently as the late 1950s (D. Tabb and W. Robertson, pers. observations). Similarly, as recently as the late 1960s the headwaters of Taylor Slough and the East Everglades were important foraging habitats for Wood Storks from the now-abandoned Madeira Rookery in lower Taylor Slough (J. Ogden, pers. observations). Even the finger glades of Long Pine Key, now for the most part drained, were common feeding areas for Wood Storks in the 1940s and 1950s (E. Winte, pers. observations).

Loftus et al. (1992) suggest that the numerous rockland solution holes scattered throughout the higher elevation marshes that are characteristic of the Taylor Slough basin once were important refugia for fishes and aquatic invertebrates. The loss of these refugia due to regionally lowered ground water levels, mainly since 1962, has critically reduced the prey base necessary to support many larger vertebrates. The overall impression of long-time observers with respect to these basins is that the numbers for all species of larger aquatic animals, including otters, alligators, pied-billed grebes, anhinga, all wading birds, mottled ducks, and limpkins, have been substantially reduced during the past 30 years.

Aside from these qualitative observations, some quantitative studies support the same conclusion regarding the ecological degradation of the Taylor Slough and C-111 basins. A review of Wood Stork nesting patterns in the Park has shown that a relatively abrupt change in the timing of colony formation, one that has proved to be detrimental to colony success, occurred beginning in 1969-1970 (Ogden 1994). This change in timing of nesting coincided with the time when maximum water levels at a key station in northern Taylor Slough (G-789) declined to below ground surface (Van Lent and Johnson 1993). The number of sampling stations occupied by singing Cape Sable Sparrows in the Taylor Slough headwaters declined from 49 in 1981 to 12 in 1993 (Curnett and Pimm 1993). During the same period of years, habitat quality at 68 of the sampling stations in the same area, including those with singing males, was potentially degraded due to increases in the amount of woody vegetation in the marshes. The combination of reduced water depths and shortened annual hydroperiods are considered to be one of the primary environmental change that can result in invasions of woody vegetation into marshes (Kushlan et al. 1982).

The number of Roseate Spoonbills nesting and feeding in northeastern Florida Bay and in the mainland estuaries in the lower C-111 basin, respectively, has declined sharply since the early 1980s (Powell et al. 1991). This decline in spoonbill reproductive effort in the northeastern Bay occurred concurrently with changes in water delivery schedules for C-111, which presumably altered depth and drying patterns below the lower portion of C-111.

Reviews of ecological data from northeastern Florida Bay have suggested that elevated salinities have had a range of adverse impacts in the northeastern Bay, including alteration of the species composition of aquatic grass beds and reductions in the number of juveniles for several species of sport fishes (Boesch et al. 1993, McIvor et al. 1994). These salinity increases have been due to the reduction in freshwater flows entering the Bay from Taylor Slough and other mainland creeks.

These observations suggest that much of the ecological decline in this region has occurred since the 1960s. This time frame is consistent with the period of major alterations in the hydrology of the Taylor Slough and C-111 basins (Johnson and Fennema 1989, Loftus et al. 1992, Van Lent et al 1993, Van Lent and Johnson 1993). These authors show that significant lowering of water depths in the Taylor Slough headwaters began during the 1960s, and that by the late 1980s peak depths were 2 feet lower than the historical peaks. This magnitude of hydrological change has caused reductions in annual hydroperiods in upper portions of Taylor Slough of from 1 to 4 months, and has resulted in large areas of marshes no longer being flooded by surface water except during the wetter years.

ECOLOGICAL RESTORATION GOALS

Two basic assumptions underlie the ecological restoration goals for the Taylor Slough and C-111 basins and the downstream estuaries of northeastern Florida Bay. These are (1) that ecological restoration will for the most part only be achieved to the extent that hydrological restoration is achieved, and (2) that maximum restoration of ecological structure and function will require maximum recovery of the spatial extent and landscape heterogeneity of the system (Weaver and Brown 1993).

Specific ecological restoration objectives for the Taylor Slough and C-111 basins and Florida Bay are listed in the reports for sub-regions 7 and 8 in Weaver and Brown (1993). Four highly important, but representative, restoration objectives included in these lists should be emphasized here: (1) the recovery of keystone/indicator species, including pre-drainage wading bird nesting colony patterns, alligator reproductive patterns, and freshwater fish population movement and survival patterns, (2) the recovery of viable populations for all endangered and threatened species, (3) reestablish the upland freshwater source to mangroves and coastal wetland communities to restore their natural productivity and ecologically important detrital export to estuaries, and (4) the reestablishment of more natural spatial and temporal patterns of salinities in coastal estuaries.

Biological restoration of the Taylor Slough and C-111 basins also must be viewed as a companion endeavor with the Shark Slough restoration program. Although Taylor Slough and Shark Slough represent somewhat separate hydrological basins, their geographical proximity and complementary hydrologic systems support a single, dynamic wildlife community. Species with relatively large spatial requirements (Snail Kite, wading birds, etc.) are dependent on the combined habitat conditions in both of these basins for their survival. For example, the higher-elevation, short-hydroperiod marl prairies and the mainland estuaries, once much more extensive and/or more productive, served as essential early dry season foraging areas for Park-wide populations of wading birds.

ASSESSMENT PROTOCOL

Because environmental evaluations of the alternative structural plans for the C-111 project had to conducted in a period of approximately 8-10 weeks, and before species models for this purpose have been completed and tested, a more rapid evaluation process had to be developed. Our approach was to establish a small team of Everglades biologists/ecologists to (1) recommend the best evaluation process possible for the time frame available, and (2) conduct the environmental evaluations. The evaluation team consisted of John C. Ogden, chairman (NPS/EVER), Dr. William B. Robertson, Jr. (NPS/EVER), Joe Carroll (FWS/Vero Beach), Janet Ley (SFWMD/West Palm Beach), Gerald Atmar (COE/Jacksonville), and Dr. G. Thomas Bancroft (Natl. Audubon Society/Miami).

The evaluation team identified a series of ecological relationships that have been reasonably well demonstrated in the Everglades system, and for which some assessment of the alternative plans might be possible given the nature of the model output from the 1X1 hydrological model. The list of environmental relationships is presented below. For each of these ecological relationships, the team attempted to determine the number of 1X1 cells that showed improvement, degradation, or no change in habitat conditions, compared to the base condition, based on predicted changes in the hydrology in each cell.

The following ecological relationships were proposed for use in the evaluation of the alternative structural plans.

(1) Wood Storks. It has been shown that the timing of stork colony formation influences colony success rates, and that earlier colonies are more likely to be successful than are later forming colonies (Ogden 1994). It has also been shown that stork colonies in the park form earlier in years when extensive areas of the higher elevation, marl prairie marshes are flooded during the early dry season (November-December) than in years when these prairies are dry in these months. The evaluation will compare predicted changes in the number of cells located in the marl prairie portion of the study area that show surface water flooding during November and December. The preferred alternative will be the plan that shows the greatest increase in flooded cells for this region and these months.

(2) Roseate Spoonbill. Studies of spoonbill nesting patterns in eastern Florida Bay have shown that colony success is greatest when adult birds can find adequate feeding conditions in the mainland wetlands in the lower portions of the C-111 and Taylor Slough basins, especially during the nestling period from January through March (Bjork & Powell 1993). Ideal foraging conditions are created by extensive flooding early in the nesting season (Nov.-Dec.) followed by moderate, regional drying patterns through March. When drying is too slow, prey are not adequately concentrated; when it is too rapid, the adult birds are forced to fly greater distances to find adequate foraging sites. A preferred plan will be the one with the greatest number of cells in the lower basins flooded during November, and with 50-75% of these cells dry by end of March. A lower percentage of dry cells in March would indicate an inadequate drying rate, while a higher percentage would indicate a too-rapid drying rate, resulting in an unacceptably extensive drying of foraging habitats within range of the colonies.

(3) Cape Sable Sparrow. It has been shown that Cape Sable Sparrow nesting colonies only occur in marshes that lack even sparse amounts of woody vegetation (Werner 1975). Invasion of marshes by woody vegetation can occur

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where annual hydroperiods and/or water depths are reduced (Kushlan and Bass 1983, Taylor 1983). The preferred alternative will be the plan that shows the greatest increase in the number of flooded cells during the summer wet season (July-October), and following the sparrow nesting season (February-June; Werner 1975).

(4) American Alligator. It has been shown that the number of adult female alligators that initiate nesting during June each year is proportional to the area of surface flooding in the sloughs during the alligator pre-nesting, courtship period in April and May (M. Fleming unpublished data). Cells that occur in Taylor Slough will be compared for surface water patterns during the courtship months, with the preferred alternative being that plan which has the highest number of flooded cells for these two months.

(5) Freshwater fishes. It has been shown that increases in the length and spatial extent of uninterrupted, between-year hydroperiods results in increases in density and biomass of fishes (Loftus and Eklund 1994). The preferred alternative will be that plan that shows the largest number of cells in Taylor Slough with uninterrupted, inter-annual flooding.

(6) Freshwater fishes. It has been proposed that solution holes in the marl prairies are important refugia for fishes and aquatic invertebrates when the marshes in these areas lack surface water (Loftus et al. 1992). Data collected by Loftus suggest that when water levels drop more than 1 m. below ground level, that the presence of these aquatic animals in solution holes is much reduced. The preferred alternative will be the plan that has the fewest cells in the marl prairie regions with water levels that drop more than 1 m. below ground for one or more months during the year.

(7) Estuarine fishes. Data have been collected that suggest that higher numbers and biomass of fishes during the dry season in the mainland estuary in the lower C-111 basin are associated with relatively deeper flooding during the later months (September-October) of the preceding wet season (J. Lorenz unpublished data). Based on the Lorenz data, the preferred alternative will be the plan that predicts the largest number of cells in the lower C-111 and Taylor Slough basins with surface depths greater than 0.5 feet of water during the late wet season months, September-October.

(8) Emergent aquatic plants. An earlier ecological assessment of the Taylor Slough basin has suggested that drying greater than 24-30 inches below ground surface results in stress to root systems of emergent aquatic plants (Tabb 1987). We propose to select a preferred alternative for this relationship by identifying the plan with the fewest cells showing subsurface drying greater than 30 inches for two or more consecutive months per year.

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(9) Periphyton. A review of periphyton community dynamics in the Everglades has suggested that areas with 1 to 5-7 month hydroperiods will be dominated by blue-green algal communities, while areas with 7 to 12 month hydroperiods will be dominated by diatom/green algal communities (Browder et al. 1994). This review also suggests that diatoms/green algae are more important in Everglades food chains, and that shifts in community composition due to shortened hydroperiods may have caused fundamental changes in productivity in Everglades marshes. The preferred alternative will be the plan that shows the largest number of cells with 7 to 12 month hydroperiods.

(10) Soil indicators. An earlier assessment of the ecology of the Taylor Slough basin suggested that the broad marl prairies should experience maximum hydroperiods that average 6-7 months, if these regions are to be ecologically healthy (Tabb 1987). A preferred alternative for this relationship will be the plan that produces the largest number of cells with 6-7 month hydroperiods in years with average rainfall.

This list of environmental relationships does not include eastern Florida Bay components because the 1X1 model does not extend as far south as the Bay or into the mainland estuaries immediately along the north shore of eastern Florida Bay. For this reason, and because no mathematical relationship between upstream water flows and northeastern Bay salinities has been developed, no quantitative evaluation of environmental responses in the Bay was possible for this report.

The environmental team based its evaluations on output from the 1X1 hydrological model, programmed to run with the current rainfall-based delivery formula and using the currently authorized operational criteria for optimum canal stages. For the environmental evaluations, the output from the model runs were processed by the EVER modeling team (R. Fennema et al.). These processed data consisted of separate sets of maps showing average annual water depths and annual hydroperiods for each 1X1 cell for Base conditions and for each alternative plan, for a wet year (1968-69), dry year (1973-74) and a normal rainfall year (1976-77). These data also were presented in summary tables, which included a monthly breakdown of the number of cells with surface water and the number of cells with annual hydroperiods in different depth classes, for each plan and year.

For the purposes of these environmental evaluations, three different subsets of the 1X1 cells were identified, representing three separate habitat types: marl prairies, central Taylor Slough, and the lower C-111 basin. The number of 1X1 cells in each of these habitat subsets were as follows: marl prairie (229), central Taylor Slough (78), and lower C-111 basin (86). End of month water depths for each cell in each subset, and for each of the three modeled years, were used in the final evaluations reported here. Only the subset of cells that was appropriate for the specific relationship being examined was used in each of these final evaluations.

RESULTS

Our evaluations are summarized below. For two reasons the team did not conduct environmental evaluations for all 10 of the ecological relationships identified in the above list. First, the post-processing of the 1X1 model output was unable to produce the hydrological data in all of the different formats required for these evaluations, in the time available for conducting these evaluations. Thus the team only was able to conduct five of the proposed evaluations, for the Wood Stork, Cape Sable Sparrow, American Alligator, Roseate Spoonbill and for the hydroperiod/freshwater fishes relationship. And secondly, because the hydrological data shown for the groupings of cells within each habitat subset were essentially identical, from an ecological perspective, both among the different alternative plans and between the Base condition and the alternative plans, the evaluation team was comfortable with the decision to produce an evaluation report for a sample of the ecological relationships representing each of the three habitat subsets of cells.

Marl Prairies:

1. Wood Stork. This evaluation compared differences in the areal extent of surface flooding in the marl prairies during the traditional months of colony formation, November and December. The preferred alternative plan would be the one showing the greatest increase, compared to the Base condition, in the number of flooded cells during these months in the marl prairies.

The combined two month total number (maximum 458 cells) of flooded cells during November and December for Base condition and for each plan are as follows (percentages are % increase compared to Base):

Base: Wet year= 298 cells; Dry= 250 cells; Norm.= 262 cells.
Plan 1: 306(1.0%); 254(1.6%); 271(3.4%); (cumulative 3 year increase: 2.6%).
Plan 2: 309(3.6%); 252(0.8%); 272(3.7%); (3.4%).
Plan 3: 333(10.6%); 270(7.7%); 302(13.3%); (10.5%).
Plan 4: 320(6.9%); 270(7.5%); 298(12.1%); (8.8%).
Plan 5: 323(7.8%); 259(3.5%); 293(10.6%); (7.5%).
Plan 6: 320(6.9%); 262(4.6%); 294(10.9%); (7.5%).

Plan 3 scored highest in all three years; Plan 4 scored 2nd highest, followed by

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plans 5 and 6. Although differences among plans 3, 4, 5 and 6 were not great, these four plans were stronger than plans 1 and 2. Thus it may be concluded that Plans 3 through 6 potentially can produce larger areas of early dry season foraging habitat for Wood Storks than can the other Plans or the Base condition, and therefore are more likely to improve stork reproductive effort in the southeastern Everglades.

2. Cape Sable Sparrow. Assuming that surface flooding in the marl prairies during the July through October wet season is an important control for woody plant invasion into sparrow nesting habitat, the plan showing the greatest increase in number of flooded cells, compared to the Base condition, would best benefit the sparrow. We scored each alternative plan for the cumulative, total number of cells flooded during these months (percentages are % change from Base):

Base: Wet year= 841 cells; Dry yr.= 688 cells; Normal yr.= 688 cells.
Plan 1: 846(0.6%); 704(2.3%); 707(2.7%); (cumulative increase= 1.8%).
Plan 2: 853(1.5%); 737(6.7%); 742(7.3%); (5.0%).
Plan 3: 856(1.8%); 758(9.3%); 766(10.2%); (6.9%).
Plan 4: 841(0.0%); 751(8.4%); 761(9.6%); (5.8%).
Plan 5: 854(1.6%); 758(9.3%0; 758(9.3%); (6.5%).
Plan 6: 844(0.4%); 748(8.1%); 753(8.7%); (5.5%).

Plans 2 through 6 show greater increases in total number of flooded cells during the wet season, than does Plan 1, and presumably would benefit sparrow habitat by having greater potential for controlling woody plant invasion into the marl prairie marshes. The strongest plans appear to be 3 and 5.

Taylor Slough:

3. American Alligator. The assumption is that the number of adult female alligators initiating nesting each June will be proportionate to the area of Taylor Slough that is flooded during the April-May courtship period. Thus the plan showing the largest increase in flooded cells in these 2 months should show the most improvement in nesting effort compared to Base. The combined April-May totals for Base and each Plan are as follows:

Base: Wet year= 102; Dry= 4; Norm.= 65; Cumulative total= 171.
Plan 1: 103; 6; 65; Total= 174.
Plan 2: 101; 3; 69; Total= 173.
Plan 3: 101; 2; 69; Total= 172.
Plan 4: 102; 3; 67; Total= 172.

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Plan 5: 101; 3; 68; Total= 172.
Plan 6: 101; 4; 66; Total= 171.

This evaluation shows no difference among the different plans in the number of flooded cells in central Taylor Slough, and no difference between the plans and the Base condition.

4. Freshwater fishes. This evaluation assumes that the Plan that shows the fewest number of dry cells in Taylor Slough will be the Plan that most improves reproduction and survival among fishes. The hydrological evaluation of the 1X1 model output shows that the driest months occur in February, March, April and May, the months with the fewest flooded cells. For each Plan, the four month cumulative total of dry cells is compared with the cumulative total for the Base condition:

Base= Wet year= 96; Dry= 300; Normal= 202; Total= 598 dry cells.
Plan 1: 94; 297; 201; Total= 592.
Plan 2: 97; 302; 192; Total= 591.
Plan 3: 97; 301; 199; Total= 597.
Plan 4: 95; 297; 197; Total= 589.
Plan 5: 97; 304; 203; Total= 604.
Plan 6: 96; 297; 201; Total= 594.

This evaluation shows no meaningful difference among the six alternative plans in the number of dry cells, and no habitat improvement (reduction in dry cells) between Base and the plans.

Lower C-111 Basin:

5. Roseate Spoonbill. The evaluation for spoonbill habitat cells is based on information that shows that nesting success is reduced in years when extensive drying or flooding occurs during the months of the nesting cycle. Our assumption is that ideal foraging habitat is created when more moderate drying rates our, when between 50% and 75% of the cells that are flooded in November become dry by the following March. The following evaluation shows the percentage of cells that become dry between November and March. The preferred plans will be those that show more than 50% and fewer than 75% of the cells drying during this period.

Base: Wet year= 23.8% drying; Dry= 100%; Normal= 65.2%.
Plan 1: 18.8%; 100%; 65.7%.
Plan 2: 21.0%; 100%; 64.8%.

Plan 3: 13.6%; 100%; 66.7%.
Plan 4: 17.5%; 100%; 70.9%.
Plan 5: 25.0%; 100%; 68.7%.
Plan 6: 20.0%; 100%; 65.2%.

Neither the Base condition nor any of the plans are predicted to provide suitable foraging habitat during wet and dry years. The best wet year drying rate occurred under Plan 5. The Base condition and all plans provide suitable foraging habitat during the normal rainfall year, although the six plans show no meaningful improvement compared to the Base condition.

DISCUSSION

The results from these five environmental evaluations suggest that while plans 3-6 may provide greater ecological benefits, this type of evaluation does not reveal strong environmental benefits from any of the proposed plans. None of the plans are predicted to provide greater than 10% increases in the number of improved habitat cells. Even this low level of improvement may be of no ecological significance, in view of the assumed, but unmeasured, degree of error that is inherent in all models. More specifically, these evaluations show no changes in the numbers of improved habitat cells in the Taylor Slough and lower C-111 basins, and very modest improvements in the Marl prairies.

A more positive perspective is that alternative plans 3 through 6 show potential for habitat improvement in the marl prairies, the habitat type that appears to be most in need of restoration. Irrespective of the actual water depth values produced by the 1X1 model, the fact that the output for all of the alternative plans, especially 3-6, all show increases in the number of improved habitat cells strongly suggests that these plans potentially can meet the restoration targets set for this region, once improved delivery formula and operational criteria are in place.

The primary reason why these plans do not show strong environmental benefits is because they each have been modeled with essentially the same delivery formula and operational criteria. The different structural modifications being evaluated do no more than move a fixed amount of water around to different places in the Taylor Slough/C-111 basin. Thus each plan tends to improve habitat conditions in one location at the expense of habitat conditions in a different location. The fact that the model output shows much greater hydrological responses among the three different categories of rainfall years than among plans within a year shows that substantial increases in total, regional volumes of water will produce much greater numbers of improved habitat cells than will structural modifications alone.

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The environmental evaluation team agrees with the hypothesis that the initial focus for ecological restoration must be on achieving hydrological restoration (Weaver and Brown 1993). The test for this hypothesis requires that a strong, regional ecological monitoring program be developed to be implemented as an integral part of the C-111 project. The environmental evaluation team assumes that a more useful assessment of environmental benefits from the C-111 project will be produced once further structural improvements identified by the current hydrological evaluation of alternative plans are incorporated, and a set of alternative operational plans are modeled.

LITERATURE CITED

Hydrological Evaluation of the Proposed Alternatives for the U.S. Army Corps of Engineers' General Re-evaluation Report for the C-111 Basin

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1 Executive Summary

The restoration of Everglades National Park is possible only if the extent and duration of surface water inundations and surface water flows are brought back to more natural levels, resembling pre-drainage conditions. The Army Corps of Engineers C-111 General Re-evaluation process was designed to address flood control, environmental enhancement, and water management improvements in the C-111 basin. This report describes the predicted hydrological impacts on the water resources of the Park and adjacent areas caused by each of the structural alternatives proposed in the GRR process. The analysis relied entirely on output from the South Florida Water Management District's 1x1 version of the South Florida Water Management Model (Version 1.2), which was modified by the District and the Corps to simulate each of the alternatives.

- The Park's criteria for the evaluation of the structural alternatives focused heavily on the re-establishment of more natural surface water and groundwater levels in the wetlands of the C-111 basin. As proposed, all of the alternatives would provide only very modest improvements in ground and/or surface water levels in these natural areas. Most of the salient items offered in the alternatives provide for increased flood control and drainage for the eastern developed areas, but do little to address the continued environmental degradation of the natural areas west of the Eastern Protective Levee System.

- Alternatives 1, 2, 3, 5 and 7 provide increased flood control and water supply benefits by pumping into the main channel of Taylor Slough through large pumps located at a single location. In contrast, alternatives 4 and 6 use five moderate size pumps to spread water out over the wetlands of the Rocky Glades and northern Taylor Slough. The increased pump capacity in the headwaters and northern portion of the Taylor Slough basin provide for large increases in wet season flows through the Taylor Slough Bridge cross-section, but produce only modest additional flows into the downstream areas of Taylor Slough and Florida Bay.

- None of the alternatives significantly restore more natural conditions in the Eastern Panhandle watershed of the lower C-111 basin, however all plans degrade the spoil piles on the southern bank of the C-111 canal. Alternative 5 partially backfills the C-111 canal south of S-18C, and Alternatives 3 and 4 backfill the canal completely south of the confluence with C-111E. All, except Alternative 7, place plugs in C-109 and C-110,

but do not backfill the canals. Additional flood control and water supply discharges to the Eastern Panhandle are proposed in all but Alternative 7. A new spreader canal (C-500E), aligned eastward from the confluence of the C-111E and C-111 canals, is added in Alternatives 1 through 6. This canal would be supplied by either a 50 cfs pump (Alternatives 1, 2, and 6) or a 500 cfs pump (Alternatives 3, 4, and 5).

- Alternatives 2 through 6 lower wet season water levels in the L-31N canal, and throughout much of the eastern developed areas, to levels well below those predicted for the Base condition. Water budget computations indicate that this practice leads to continued over-drainage of the Rocky Glades and northern Taylor Slough wetlands. Low wet season water levels in the L-31N, C-111, and coastal canals also cause massive seepage losses to the east. Average annual seepage losses from the marshes west of the L-31N canal were in excess of 225,000 acre-feet, under the Base condition. For comparison, average annual inflows to the Shark Slough basin are approximately 550,000 acre-feet under the current operating schedule. This indicates that a large proportion of the water deliveries to the Park are lost, due to the maintenance of low water levels to the east.

- Our assessment showed that Alternatives 2 through 6 slightly lower groundwater levels in the western developed areas of the Rocky Glades and the Frog Pond, but groundwater levels will remain high under the base condition, and all of the proposed alternatives. Under all of these plans, the developed areas are subject to frequent root zone flooding under normal wet season conditions, and short periods of surface water inundations during extreme storm events. Flooding problems in these areas will continue to occur because of the low-lying nature of these lands, and their close proximity to the Everglades.

Our assessment of the alternatives was based solely on the predicted impacts of the proposed structural modifications. While this approach may be an acceptable method for designing flood control projects, it does not work for a multi-purpose project designed to also provide environmental benefits. Hydroperiods (the duration of surface water inundations) and hydropatterns (the spatial extent of surface water inundations) are the most important aspects of the Park's hydrology and, today, they are largely controlled by the operational levels in the adjacent canals. Changes in these parameters have profound effects on the associated plant and animal communities and need to be fully evaluated.

Thus, in addition to the proposed structural changes, operational adjustments need to be implemented to properly evaluate potential environmental benefits. For example, changes in structure capacities and canal design conditions should prompt changes in operational policies. Larger pump capacities must be balanced by increases in normal canal operational stages, or the increased capacities may provide drainage beyond the authorized levels of flood protection. Increased canal operational stages in turn allow more of the wet season runoff to be stored in the adjacent aquifer, which reduces dry season supplemental water demands. Higher wet season canal stages also reduce seepage losses from the wetlands and let the adjacent marsh water levels remain higher. These operational changes must be evaluated at the same time as the testing of structural alternatives, or the multiple purposes of the C&SF Project cannot be properly balanced.

Using our knowledge of the surface water and groundwater hydrology along the Park's eastern boundary, and the history of past water management problems in these areas, we have developed a conceptual plan which we believe will provide the authorized levels of flood protection to the eastern developed lands, while allowing for significant improvements in the hydrology of the adjacent natural areas. This new alternative would create a buffer zone between the eastern developed areas and the Park, which would provide an area to temporarily store excess runoff, before it is passed into the wetlands of the Park. This approach would:

1) improve the timing and duration of surface water inflows to both the Park and state lands,

2) reduce the documented over-drainage of the adjacent wetlands, and

3) allow the re-establishment of higher wetland stages throughout the natural areas of Northeast Shark Slough, Taylor Slough, and the lower C-111 basins.

All of these watersheds are hydrologically linked, and modifications proposed under separate GDM's, GRR's, FDM's, etc. do not allow for a comprehensive evaluation of the hydrological impacts, or ecological benefits, of proposed structural and operational modifications. Further evaluations, which will allow the testing of significant changes in both structures and current operational practices, are required before a preferred alternative can be reasonably selected.

2 The Flat, Wet, Lonely Wilderness

That is what Daniel N. Beard called Everglades National Park in his Special Report on the Everglades National Park Project in 1938 and he added

...and so it must remain forever.

The reasons for establishing an Everglades National Park have not changed much since 1938, the Everglades are indeed a more subtle and dynamic environment than most areas with outstanding geographic features. Conservation of a fragile ecology, so dependent on the seasonal fluctuation of water levels were concerns in 1938 as much as they are today.

Fifty years later, 1988 brought more of the same, low water levels, coupled with a natural drought and artificial canal drawdowns. Water levels in the Rocky Glades, the headwaters of Taylor Slough, barely poked through to the surface. Unrelenting drainage of the swamp continues to take its toll, altering the landscape so much that today even slow-evolving biota, such as marsh vegetation communities, can be observed to disappear and be replaced by woody vegetation. Daniel B. Beard knew about the problem stating in his chapter on "The Effects of Human Use, Drainage:"

The most important problem to be settled before the Everglades Park is established is that of restoring water levels ...

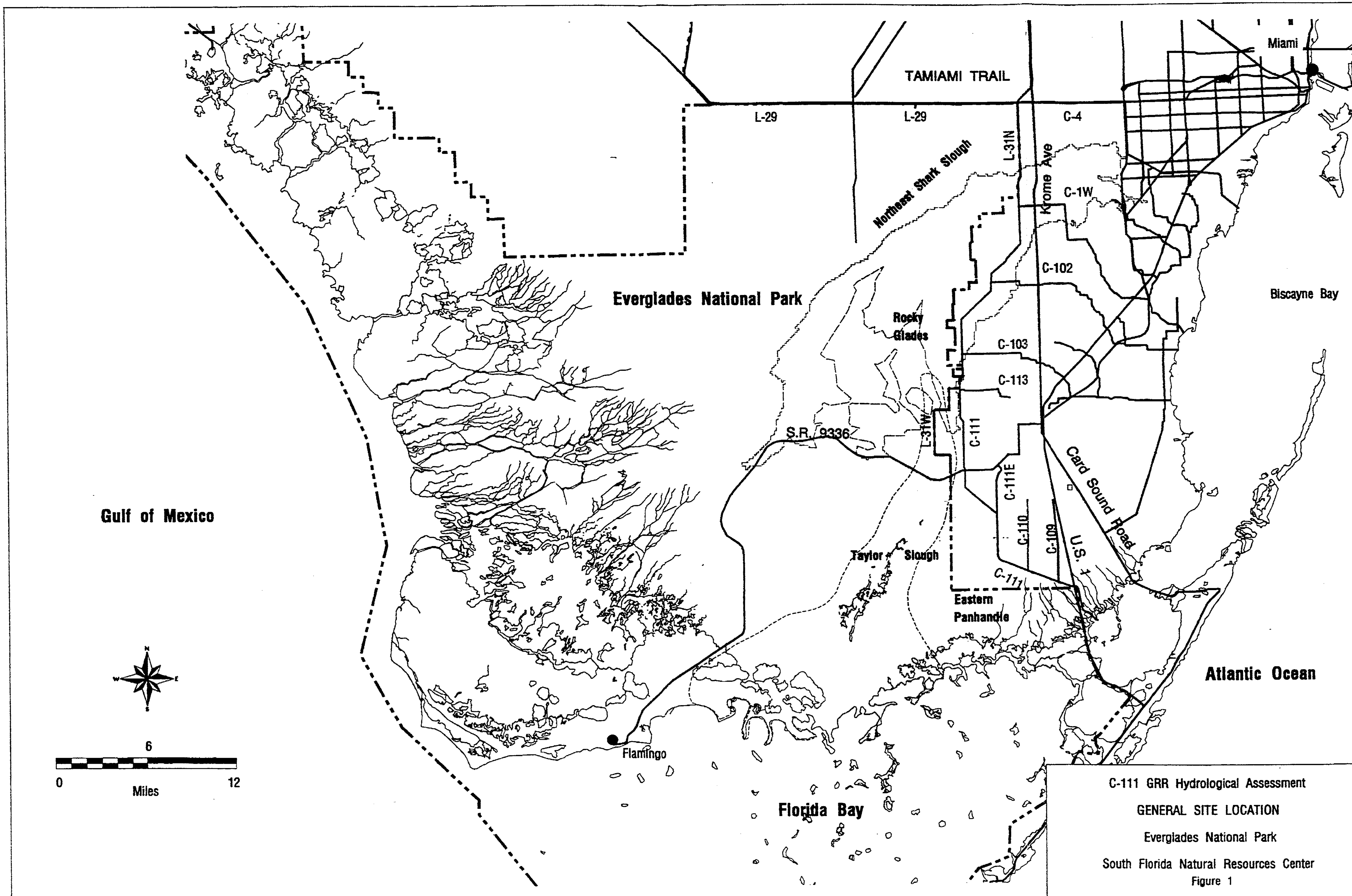
Serious efforts are needed to recreate the basic hydrology of a pre-drainage Park. Not until the long term decline of water levels has been reversed can restoration efforts begin to be addressed. Perhaps a synergistic approach coupled with wise administration will begin to show the results so that his goals may finally be realized:

In fifty years, the Everglades National Park is capable of becoming an outstanding place.

3 Introduction

The purpose of this report is to provide a hydrological assessment of the proposed modifications to the canals and water contiol structures of the C-111 drainage basin. The C-111 basin covers an area of approximately 100 mi^2 and extends southward from Tamiami Trail to Florida Bay, and from the western side of the Atlantic Coastal Ridge well into Everglades National Park (ENP). The principal north-south levees and drainage canals are L-31N and C-111 (Fig. 1). These levees, canals and associated structures were constructed as part of the Eastern Protective Levee System (EPLS) of the Central and Southern Florida project (C&SF Project), authorized by the Flood Control Act of 1948 (PL 80-858). The Flood Control Act of 1954 (PL 83-780) authorized construction of the L-31W canal and levee. The Flood Control Acts of 1954 and 1962 (PL 86-645) authorized construction of the C-111 canal and levee system and improvements to several of the south Dade coastal canals (see [Lent *et al.*, 1993] for an overview). The primary purpose was to provide flood control for the developed lands east of the L-31N and C-111 levees. The development of this flood control project has led to severe over-drainage of wetlands in and adjacent to Everglades National Park. Concerns about the loss of natural habitats in the wetlands and degradation of Florida Bay sparked the process to develop solutions to reverse the decline of these natural areas.

The 1963 Corps GDM for South Dade County stated that the L-31N, C-102, and C-103 canals were to be constructed so that, during the design storm, approximately 28 square miles of land east of L-31N and west of the Seaboard Airline Railroad would be drained westward into Taylor Slough via L-31W canal [U.S. Army Corps of Engineers, 1963b]. The L-31W canal was specifically added as part of the 1963 GDM to replenish the freshwater supply to Taylor Slough. Unfotunately, the construction of the canal further divided the headwaters of Taylor Slough, placing a large portion of the watershed east of the L-31W canal, within the area now known as the Frog Pond. The initial GDM operational plan specified that S-175 and S-176 would remain closed under normal conditions. L-31N would be held as high as 6.5 ft. NGVD to promote the discharge of water into L-31W via S-174. Water would then spill overbank from the L-31W canal into Taylor Slough. Under flood conditions, up to 500 cfs would be discharged into L-31W via S-174 and out S-175, to maximize Taylor Slough inflows. The Everglades National Park-South Dade Conveyance System (SDCS) was authorized by Congress in 1968 (PL 90-483) to increase the conservation and conveyance of water supplies to ENP and the developed areas of South Dade. Improvements were made in the L-31N canal



C-111 GRR Hydrological Assessment

GENERAL SITE LOCATION

Everglades National Park

South Florida Natural Resources Center

Figure 1

GRASS-ARC/INFO site 12/05/1993

to increase dry season water deliveries to Taylor Slough via canal L-31W and pump station S-332 (see [Lent *et al.*, 1993]).

3.1 The Natural Features of the C-111 Basin

A generalized soils information superimposed with preliminary ground surface elevations in this portion of southern Dade County is shown in Fig. 2. The soil associations and related land elevations define the original landscape features within the C-111 basin. The soils information was taken from a University of Florida publication entitled Soils Associations of Dade County, Florida [Leighty *et al.*, 1954]. The ground surface elevations are from a GIS database developed by the Park, based on topographic surveys made for the SFWMD, COE, and ENP. This elevation contour map and existing soils data of the C-111 basin are used to define the landscape features important to the wetlands. A comparison of this recent data and the model's grid cell elevations has not been done. The contour map is being drawn to refine the elevations in use in the SFWMM and the natural system version. Further work is needed to refine the elevations to include the small-scale features of the landscape.

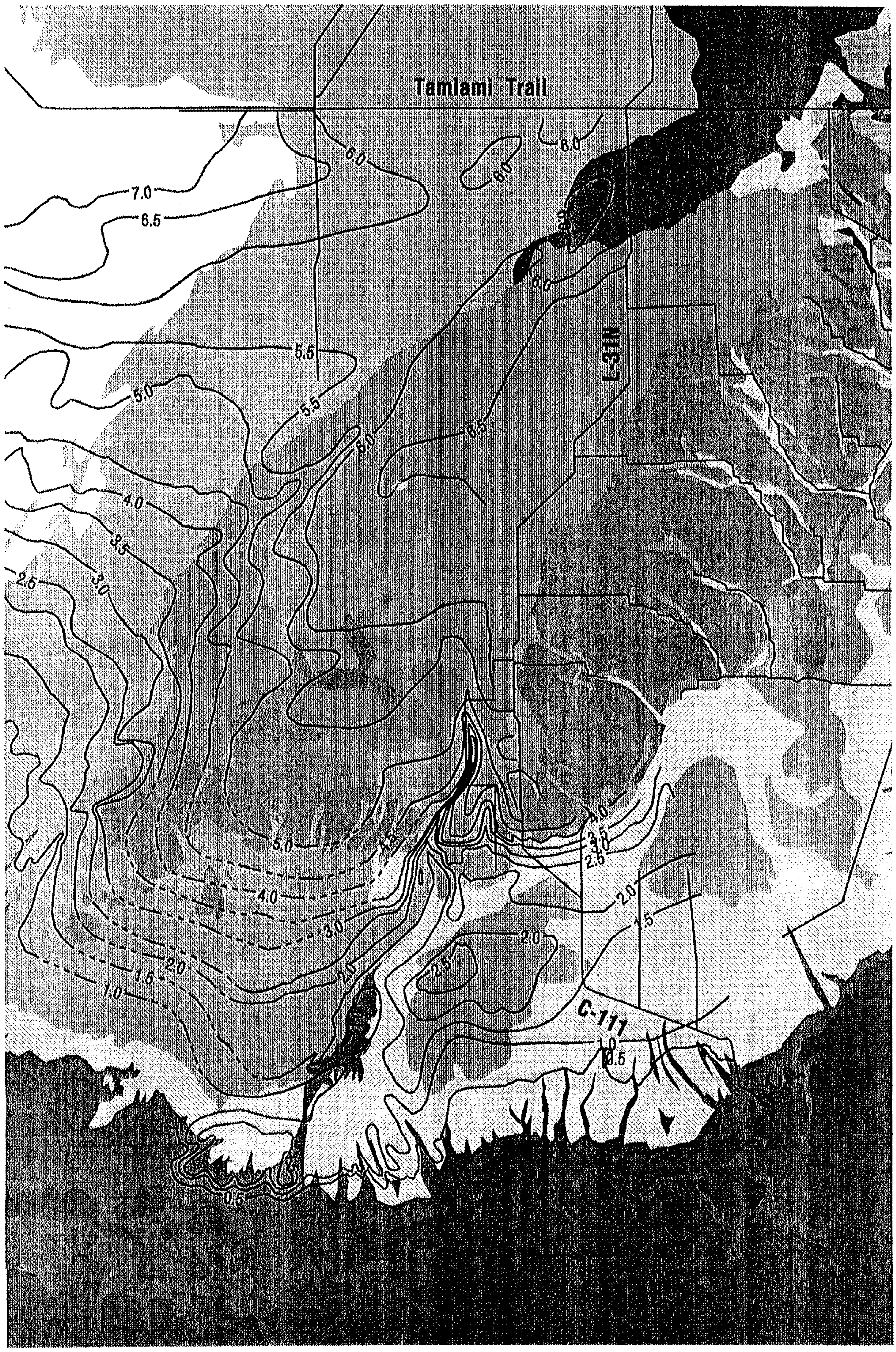
Much of the following site description is taken from an excellent summary on the physiographic features and original ecological conditions of the lower Everglades, Florida Bay, and the Florida Keys developed by the U.S. Fish and Wildlife Service [Shomer and Drew, 1982]. The soil descriptions indicate that all of the study area, except the higher elevated Atlantic Coastal Ridge (underlain by Rockdale fine sandy loam), was originally subject to seasonal flooding, due to the low elevations and/or poorly drained soils. Shark Slough shows up as the broad southwesterly trending arc of continuous wetlands underlain by Loxahatchee and Everglades Peats, which historically were inundated throughout most of the year. This is the continuation of the Everglades trough, which is a wide, slightly concave depression in the underlying limestone. Northwest of the Shark Slough wetlands the bedrock of the Everglades rises gradually into the Big Cypress Spur. This area is underlain by the Ochopee Marl. To the southeast of Shark Slough is an area referred to as the Rocky Glades (underlain by Rockland soils) which was historically inundated for a few months each year, at the peak of the wet season ([Shomer and Drew, 1982]). The name Rocky Glades was derived from the character of the limestone pinnacle rock exposed at the surface of much of this area. In its natural state, this area was characterized by rocky, open, muhly grass prairies, with thin eroded marl soils overlying a solution riddled limestone surface. The southern portion of this area slopes to the southeast, and forms the headwaters of the Taylor Slough watershed. This area historically provided surface water inflows principally from the low-lying portions which are underlain by the Perrine Marl.

This poorly drained, low-lying area extends for some distance eastward throughout much of the Frog Pond, and northward along the western flank of the Atlantic Coastal Ridge. From this point, the marl soils run southward down Taylor Slough, through a breach in the Atlantic Coastal Ridge. This isolated western-most extent of the Coastal Ridge forms Long Pine Key, which is the only high ground area in this portion of the Park. The soils and elevation information in this area clearly shows that much of the headwaters of the Taylor Slough watershed occurs to the east of the L-31W and C-111 canal and levee systems, well outside of the protected areas of the Park. The construction of these levees and canals has therefore isolated a large portion of the historical contributing area to Taylor Slough, which is a major reason for the long-standing conflicts over water management in this area. Most of the northern Taylor Slough basin west of L-31W has ground surface elevations in excess of 4.5 to 5.0 feet. In contrast, the very low elevations along the alignment of the L-31W canal and southward from the S-332 pump station, form a distinct dry season flowway, that historically maintained longer hydroperiods than the adjacent marshes. This area has continue to support a longer hydroperiod that the adjacent marshes following the implementation of dry season pumping at S-332. South of the main park road, the marl soils are deeper and are underlain by scattered areas of peat. Hydroperiods in this area increase due to additional surface water inflows from a second natural flowway located along the alignment of the lower L-31W canal. This area historically also received runoff from the marl areas along the eastern side of the Frog Pond. A portion of these flows have continued, to some extent, by wet season releases through S-175.

The lower C-111 or Eastern Panhandle basin is part of the Southeast Coastal Glades, which are underlain by a mixture of freshwater (Perrine) marls in the areas adjacent to the Coastal Ridge that transition into the Flamingo Marl near the coast. The Flamingo Marl forms in areas characterized by more salt-tolerant grasses and sedges. The soils in this area therefore reflect the variable nature of freshwater inflows and are a mixture of marine and freshwater marls. Under natural conditions, the lower C-111 basin would have received wet season runoff from the southern portion of the lower Atlantic Coastal Ridge, and provided the only outside source of freshwater to the northeastern portion of Florida Bay. Today the original pinelands in the southern Coastal Ridge area have been lost through the urban and agricultural expansion of Homestead and Florida City. Because of the development of these areas, much

Soil Associations of Dade County

- Dade Fine Sand
- Davie Fine Sand
- Everglades Peat
- Loxahatchee Peat
- Mangrove Swamp
- Ochopee Fine Sandy Marl
- Perrine/Flamingo Marls
- Perrine Marl
- Rockland
- Rockdale Fine Sandy Loam
- Water



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C-111 GRR Hydrological Assessment

Elevations and Soils

Everglades National Park
South Florida Natural Resources Center

Plate 1

of the natural runoff is now routed eastward into Biscayne Bay. This accounts for a significant loss of natural sheetflow from the original upstream contributing area. This drainage has led to woody and exotic plant invasions into the northern marshes of the lower C-111 basin. In the mid 1960's the northern portion of the C-111 canal (adjacent to the Frog Pond) was constructed. This canal produced an artificial breach in the Coastal Ridge, that has allowed wet season runoff from northern Taylor Slough, and Northeast Shark Slough basins to be transferred into the lower C-111 basin. This has undoubtably increased wet season inflows, but the water enters at a point very low in the basin. The recent acquisition by the State of much of the northern marshes in this basin has led to increased pressure to re-introduce surface water flows as far north as possible, as a way of maximizing the benefits of natural sheetflow.

3.2 Water Management Problems in the C-111 Basin

In June, 1982, following record rainfall and widespread flooding caused by tropical storm Dennis, water levels in L-31N canal were lowered to provide flood protection to the developed areas of the East Everglades. In 1984 as part of a trade-off for increased water deliveries to Northeast Shark Slough (NESS), water levels in the canals along the eastern border of ENP were further lowered during both the dry and wet season. Development of lands formerly in low lying areas of the historical Taylor Slough watershed accelerated. Since that time the environmental degradation of the wetlands has accelerated and substantial areas in the headwaters of the Slough have lost surface water. Hydroperiods, the length of time that surface water is present during a year, were substantially reduced, to the point that these areas are losing their wetland character.

This reduction in canal water levels, below the authorized flood control elevations, has spurred an increase in farming and residential development in the East Everglades, Rocky Glades and the Frog Pond. Agricultural practices in these areas have changed from planting when water levels had naturally receded (at times this probably happened well into January) so that now seasonal crops are being planted at the height of the historical wet season. More recent demands for additional drainage to support year-round agriculture have further aggravated the lowering of marsh water levels in ENP. Farming probably took place in portions of these areas in the 1920's and definitely occurred in the 1940's in historical low-lying muck lands of Taylor Slough. With the advent of rock-plowing, a technique which breaks up the soft limestone, all of the low-lying farm lands were abandoned. As evidence, no farming activity can be found in these areas in the available aerial photos of the mid 1970's. With the ever-continuing drainage of the Everglades and the construction of L-31W, these low-lying areas again became attractive. Under the current drained conditions in Taylor Slough, it has even become possible to plant lime groves, an activity needing year-round low water levels.

Since the early 1980's, Everglades National Park has been pressing for improved water management practices in the Taylor Slough and C-111 basins, under the authority of the Congressionally mandated Experimental Water Delivery Program. We have frequently voiced our concern that the reductions in L-31N, L-31W, and C-111 canal operational stages over the past ten years were done without adequate environmental evaluations. The Park has completed numerous technical studies (see *e.g.*, [Johnson *et al.*, 1988], [Johnson and Fennema, 1989], [Loftus *et al.*, 1992], and [Lent *et al.*, 1993]) that have shown that these operational changes have caused serious wetland drainage impacts and associated ecological problems in the Rocky Glades, Taylor Slough, and the lower C-111 basin.

In November 1989, the Park sent the Corps a detailed summary of overall restoration goals for the Taylor Slough basin, related to the request for expansion of the scope of the 1988 Draft Canal 111 GDM. The Park emphasized that the starting point for all the restoration efforts should be a return to the original authorized canal operations criteria in the C-111 canal system. In 1990 the SFWMD implemented a series of structural and operational improvements as part of the C-111 Interim Project. The interim recommendations were designed as a short-term solution to two specific problems in the C-111 basin:

a) Increased flows into the lower C-111 basin resulting from the implementation of wet season stormwater pumping at S-331.

b) The lack of water management flexibility of the earthen plug (S-197) at the downstream end of the C-111 canal.

The District added a new water control structure (G-211) just south of the intersection of the L-31N and C-1W canals. This structure was installed to control seepage from Northeast Shark Slough into the L-31N canal upstream of S-331. In the lower C-111 basin the District modified the earthen plug at S-197 by adding 10 additional gated culverts. The original recommendations in the C-111 Interim Project also called for two additional operational changes in the central C-111 basin.

a) S-176 headwater stages were to be raised 0.5 feet, to reflect the reduced flood risk to the canal reach between S-331 and S-176 resulting from improved seepage control upstream of S-331.

b) The plan called for more effective use of the S-332 pump station. The District recommended that pumping be increased during the wet season to increase flows into Taylor Slough and away from the lower C-111 basin.

Neither of these changes were implemented at the start of the project because of concerns raised by South Dade agricultural interests.

In April 1993 the Army Corps of Engineers prepared a Draft Environmental Assessment for a two-year field test of improved water deliveries to the Taylor Slough basin. The plan called for implementation of the higher wet season water levels at S-176, as recommended by the SFWMD, and provisions to add supplemental pumps at the S-332 pump station to divert the majority of the L-31N runoff into the Taylor Slough watershed. This was done to reverse the current operational practices which depend on the use of S-176 to quickly route excess wet season rainfall into the lower C-111 basin. The District had also proposed backpumping water from the C-102 and C-103 canals westward to provide additional flows into Taylor Slough. This was proposed since gravity drainage from the western portions of these basins into Taylor Slough was part of the original design of the south Dade canal system, but has not been possible because of the low water levels maintained in the coastal canals. The backpumping plan was abandoned after a 1993 field test proved that pumping alone, without raising canal water levels, was an ineffective way of promoting increased flows into Taylor Slough.

The National Park Service agreed with the proposed two-year test, but stressed that the Park's major goal is to maintain optimum wet season water levels in the L-31N and L-31W canals as long as possible, and allow canal stages to recede naturally into the dry season. Strict adherence to the 5.0 and 4.5 foot temporary optimum criteria for S-176 and S-175 would be required, to avoid the potential of allowing the additional pumping capacity at S-332 to cause artificial canal drawdowns which over-drain the adjacent marshes. Common sense dictates that the only approach is to have all outflows from these canals balanced by inflows from their upstream water control structures. Lastly the Park stressed that re-establishing pre-project water levels and the natural seasonal response to rainfall in the upper portion of the Taylor Slough basin is the most reliable way of restoring natural inundations and flow patterns throughout the watershed, and improving freshwater inflows into Florida Bay.

Changes in water management in the C&SF Project have also had a substantial effect on the hydrology of the lower C-111 basin. After the L-31N canal stage reductions in 1982, and the initiation of S-331 flood control pumping in 1983 large flood water volumes drained from the upstream canal system and dumped through S-18C. These flows then passed through the C-111 gaps and S-197 ([Johnson *et al.*, 1993], [Johnson and Fennema, 1989] and [Lent *et al.*, 1993]). During the period of 1985–1988 flows through S-18C averaged in excess of 210,000 acre-feet, with nearly all the increase occuring between August and November. These excess wet season flows were greatly reduced after 1990, following the construction of the G-211 structure, which reduces seepage flows from NESS into the upper L-31N canal. The proximity of the lower gaps to tidewater meant that much of the water passed quickly through the marshes and was flushed into the estuaries of Northeast Florida Bay and Barnes Sound. The near-shore estuaries consequently suffered from rapid salinity fluctuations causing associated ecological problems ([Haunert, 1988] and [McIvor *et al.*, 1993]). Current management have shifted from providing the majority of this stormwater flow in the lower C-111, to distributing most of the flow into Taylor Slough.

To alleviate the stress on the Park's water resources, proposed structural modifications of the Project have been initiated under the Corps of Engineers General Re-evaluation Report process and seven alternatives have been proposed. These alternatives are summarized in the next section.

3.3 Summary of the Proposed Structural Alternatives

The proposed structural alternatives were summarized from a Corps of Engineers document (dated 11 August 1993) and details of the plans are shown in Figs. 3 and 4 and summarized below.

- Alternative 1. The primary purpose of this plan is to increase pumping at S-332 from 165 cfs to 1000 cfs to allow large storm water deliveries to be made to the main channel of Taylor Slough. Degrading the C-111 southern spoil piles is proposed to improve overbank flow southward into Florida Bay. A spreader canal (C-500E) is added which will provide minimal additional flood control benefits, but will add a little additional water to the impounded area north of the lower C-111 canal. The specific improvements are listed below:

  a) Construct a canal at Context road, supplied with a 50 cfs pump (S-332B) providing water to the headwaters of Taylor Slough.

b) Expand S-332 to 1000 cfs to provide additional water to the main channel of Taylor Slough.

c) Degrade the C-111 southern spoil piles, plug the C-109 and C-110 canals and build a new spreader canal east of the confluence of C-111 and C-111E, supplied with a 50 cfs pump (S-332C) from C-111.

- Alternative 2. The primary design feature of this plan is to add a new (1000 cfs) pump (S-332A) adjacent to S-174 which will discharge into a modified L-31W canal. The S-332 pump station would be abandoned. A new L-31W Extension Canal just east of the northern reach of the historical alignment of Taylor Slough, would maintain the current rated discharge capacity through to S-175. The new L-31W Extension Canal would allow the pumpage to be released as overbank flow to the west through the three western sections of the Frog Pond and then into Taylor Slough.

  a) same as Alternative 1a. Construct a canal at Context road, supplied with a 50 cfs pump (S-332B) providing water to the headwaters of Taylor Slough.

  b) Add a new 1000 cfs pump near S-174, remove most of L-31W and levee and replace it with a new canal approximately 1 mile to the east, with a capacity of 500 cfs and add a new 500 cfs gated structure (S-175A) north of S-175.

  c) same as Alternative 1c. Degrade the C-111 southern spoil piles, plug the C-109 and C-110 canals, and build a new spreader canal east of the confluence of C-111 and C-111E, supplied with a 50 cfs pump (S-332C) from C-111.

- Alternative 3. Excess flood waters would be pumped into a surge pool made up of the eastern sections of the Frog Pond and discharged into the western sections, which will act as a Stormwater Treatment Area (STA). The STA would discharge into Taylor Slough along the existing L-31W alignment through 10 culverts. This plan has the advantage that it allows for the detention and, if the culverts from the STA to the wetlands were regulated, for the slow release of excess storm water. The Spreader Canal, C-500E, would be supplied by a 500 cfs pump from C-111. This serves as the flood control outlet for lower C-111 basin, since C-111 south of S-332C would be backfilled. The overdrained triangle lands east of U.S. 1 would receive needed flow of 100 cfs.

a) A reservoir (surge pool) would be built in the eastern sections of the Frog Pond, supplied by a 1630 cfs pump (PS-332A) near S-174.

b) An STA would be constructedin the western sections of the Frog Pond, supplied through 10 culverts from the adjacent surge pool.

c) S-332 would be abandoned, and L-31W south of S-175 would be backfilled.

d) similar to Alternative 1c. Degrade the C-111 southern spoil piles, plug the C-109 and C-110 canals and build a new spreader canal east of the confluence of C-111 and C-111E, supplied with a 500 cfs pump (S-332B) from C-111. A culvert under US-1 will deliver 100 cfs to the marshes in the triangle lands east of U.S. 1.

e) The C-111 canal would be backfilled downstream of S-332B from S-18C to S-197. Abandon S-197 and S-18C.

- Alternative 4. This plan has a buffer zone between the developed, areas east of the L-31N and C-111 canals, and the natural areas of the Park. This buffer zone would extend from the southern terminus of the 8.5 mi^2 seepage levee to the intersection with L-31W. Flood control and water supply pumps would be spaced along this north-south levee with inflows supplied by L-31N. The advantage of this plan is that it allows more uniform discharge across the Rocky Glades and Taylor Slough headwaters. Unfortunately, this plan does not address the large seepage losses that occur through the levee into the developed lands west of the Eastern Protective Levee System (EPLS) formed by L-31N and C-111.

  a) Levee and canal system would be constructed which would provide water to the Rocky Glades and northern Taylor Slough through four 300 cfs pumps (S-332A, B, C, D).

  b) The East Everglades pump station (S-357) would be downsized to 300 cfs.

  c) Fill in part of L-31W, from the L-31N levee to S-332, but S-332 would be maintained and supplied with water from a new canal connected to the C-111 canal just north of S-175. The western three sections of the Frog Pond would serve as buffer areas.

  d) same as Alternative 3d. Degrade the C-111 southern spoil piles, plug the C-109 and C-110 canals and build a new spreader canal east of the confluence of C-111 and C-111E, supplied with a 500 cfs

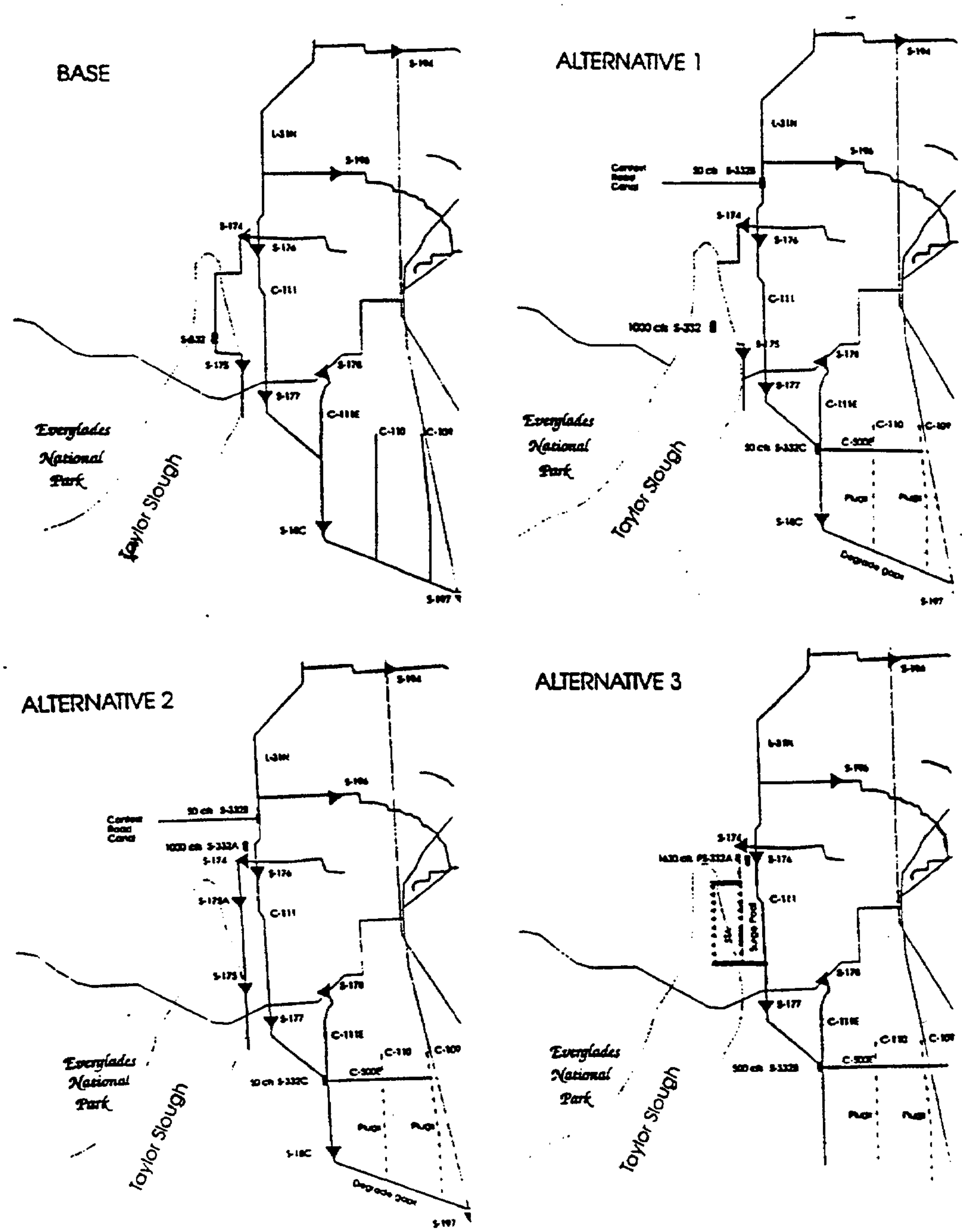


Figure 3: Sketches of Base, Alternatives 1, 2 and 3

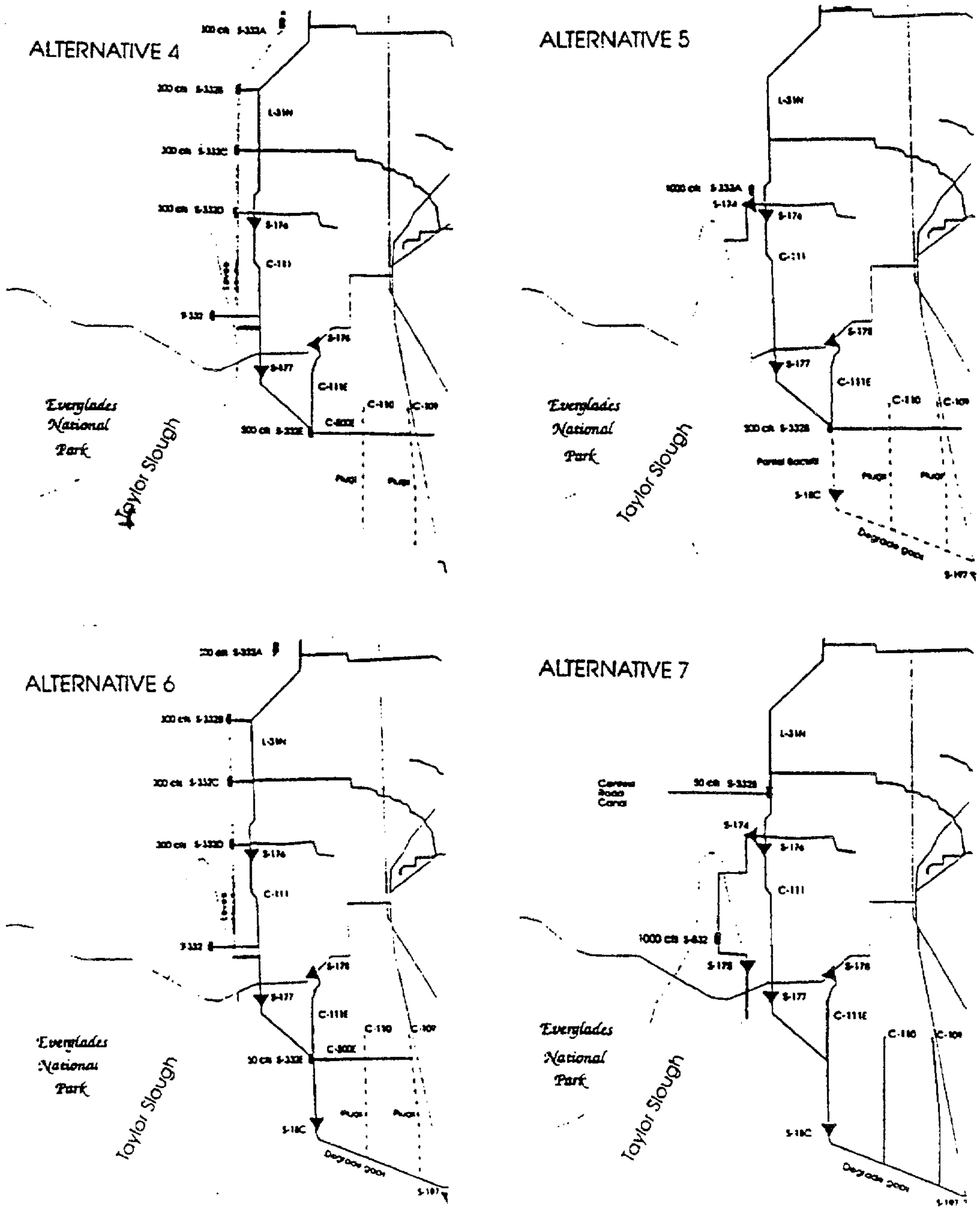


Figure 4: Sketches of Alternatives 4, 5, 6 and 7

pump (S-332B) from C-111. A culvert under US-1 will deliver 100 cfs to the marshes in the triangle lands east of U.S. 1.

e) same as Alternative 3e. The C-111 canal would be backfilled downstream of S-332B from S-18C to S-197. Abandon S-197 and S-18C.

- Alternative 5. This plan is similar in concept to alternatives 1 and 2. A 1000 cfs pump would be added near the S-174 structure and lower portion of the L-31W canal would be backfilled. The northern portion of L-31N would serve as a getaway canal for flood waters. The western sections of the Frog Pond would become part of a flow way. The lower part of C-111, south of S-18C, would be partially backfilled to retain the canal's use for flood control through the gaps and S-197. Both the north and south levees would be partially degraded. Additional flood control would be provided by the Spreader Canal, C-500E, supplied with a 500 cfs pump (S-332B).

  a) A new 1000 cfs pump would be added near S-174 and backfill part of L-31W.

  b) A flow way would be created through the eastern and western sections of the Frog Pond.

  c) C-111 would be backfilled to -6 ft. south of confluence with C-111E, and S-18C would be left operational.

  d) same as Alternative 3d. Degrade the C-111 southern spoil piles, plug the C-109 and C-110 canals and build a new spreader canal east of the confluence of C-111 and C-111E, supplied with a 500 cfs pump (S-332B) from C-111. A culvert under US-1 will deliver 100 cfs to the marshes in the triangle lands east of U.S. 1.

- Alternative 6. This plan is a combination of the Taylor Slough modifications of Alternative 4 and the C-111 modifications of Alternative 1. The principal difference with Alternative 4 is that lower C-111 and S-197 would be retained, while the Spreader Canal (C-500E) is supplied by the smaller 50 cfs pump (S-332E).

  a) same as Alternative 4a. A new 1000 cfs pump would be added near S-174 and backfill part of L-31W.

  b) same as Alternative 4b. A flow way would be created through the eastern and western sections of the Frog Pond.

c) same as Alternative 4c. C-111 would be backfilled to -6 ft. south of confluence with C-111E, and S-18C would be left operational.

d) same as Alternative 1c. Degrade the C-111 southern spoil piles, plug the C-109 and C-110 canals and build a new spreader canal east of the confluence of C-111 and C-111E, supplied with a 50 cfs pump (S-332C) from C-111.

- Alternative 7. This plan was not modeled. The design purpose is to provide large additional flood control capacity at S-332. A small additional flood control benefit is attained by degrading the C-111 southern bank spoil piles.

  a) Pump station S-332 would be enlarged to 1000 cfs.

  b) The C-111 spoil piles would be degraded.

3.4 Evaluation Criteria

The hydrologic evaluation of the proposed alternatives is aided by a numerical hydrologic model, called the South Florida Water Management Model (SFWMM), which was used to provide output on flows, stages, water depths and hydroperiods for the affected areas. A one square mile grid cell version of the model (SFWMM-1x1, version 1.2), was used in the evaluation contained herein. In order to evaluate the alternatives a base condition was established, reflecting the authorized levels of canal stages and structure operations. The output of the model for the different alternatives were evaluated for eventual selection of a preferred alternative. The selection process uses principally the following criteria:

- Operational flexibility.

  a) Provide the necessary flexibility to return to the authorized canal and structure operations.

  b) Provide the added flexibility to allow continued experimentation and fine-tuning of ENP water deliveries.

- Restoration of pre-project conditions in ENP.

  a) Drastically reduce the documented wetland drainage effects of the L-31N, L-31W, and C-111 canals.

b) Restore more natural hydropatterns and hydroperiods throughout the Rocky Glades, Taylor Slough, and Eastern Panhandle marshes.

- Restore estuarine freshwater inflows.

  a) Provide the capacity to handle flood control flows, while eliminating the need to operate S-197.

  b) Discharge excess flood control runoff as far north as possible, to help restoration of natural volumes, distribution and timing of freshwater flows to Florida Bay.

- Protect/improve water quality at ENP inflows

  a) Maximize natural wetland sheetflow as a way of preserving water quality in the marshes.

  b) Provide a means of treating poor quality water and prolonging residence times outside of existing natural wetlands.

3.5 Flood Control in the Developed Areas

Although flood protection for the developed areas was the principal reason for the C&SF Project, subsequent concerns about water supply and environmental degradation have focused on the multiple purposes of the Project. Analyses done by the Corps of Engineers during the design process ([U.S. Army Corps of Engineers, 1963b], [U.S. Army Corps of Engineers, 1963a], [U.S. Army Corps of Engineers, 1965], [U.S. Army Corps of Engineers, 1966], and [U.S. Army Corps of Engineers, 1967]) and during subsequent proposed structural modifications provide information on the levels of flood protection for the developed areas covered by the Eastern Protective Levee System. A Draft GDM for Canal 111 was prepared in July 1988 ([U.S. Army Corps of Engineers, 1965]). This report contains a detailed analysis of the C-111 basin rainfall and sets maximum canal stages and ground water levels for several monitoring gauges at different flood frequencies.

To provide maximum flood protection for the agricultural areas in the C-111 basin, the GDM contains a frequency analysis of peak annual and winter growing season rainfall in the project area for durations of one through 20 days. A log-Pearson Type III distribution was utilized to compute rainfall frequencies. The GDM also states that the 27 largest 10-day rainfall totals recorded during the growing season were most likely or entirely within October. Further in the year, the chances of flooding are rapidly reduced, eliminating the need

Return Period (Years)	Flood Duration	Monitoring Points				
		G-855	G-596	S-196A	G-789	G-613
2	1-Day	6.98	6.81	6.22	6.08	4.17
10	1-Day	8.55	7.53	8.04	$\boxed{6.91}$	4.87
25	1-Day	9.13	7.79	8.71	7.22	5.13
50	1-Day	9.51	7.95	9.14	7.41	5.30
100	1-Day	9.85	8.11	9.53	7.59	5.45
2	2-Day	6.32	6.77	5.79	5.77	3.90
10	2-Day	7.24	7.50	7.54	6.60	4.36
25	2-Day	7.58	7.77	8.19	6.91	4.53
50	2-Day	7.80	7.94	8.60	7.10	4.64
100	2-Day	8.00	8.10	8.98	7.28	4.74
2	7-Day	5.84	6.45	5.38	5.24	3.27
10	7-Day	6.52	7.01	6.42	$\boxed{6.03}$	3.65
25	7-Day	6.77	7.21	6.80	6.33	3.80
50	7-Day	6.93	7.35	7.04	6.51	3.89
100	7-Day	7.07	7.46	7.27	6.68	3.97

Source: Corps of Engineers - GDM, Addendum 2, Canal 111

Table 1: Maximum Ground Water Levels for Selected Return Periods

for massive drainage since the growing season months of November through March are mild and have not received frequent intense rainfall. Thus, after October higher canal water levels generally do not raise the risk of flooding. The higher stages are crucial, however, to continued dry season water supply and environmental preservation.

The wet season storms are generally associated with tropical disturbances and if they occur late in the season, when ground water levels are already high, these storms will produce a lot of surface water. Maximum surface and ground water levels at various locations were estimated for the existing condition and listed for various return frequencies. Relevant parts of these tables corresponding with this report's monitoring points are reproduced as Table 1. SPF is the standard project flood which is defined as 125% of the 100-year storm. HW is the headwater or upstream side of the structure and TW refers to tailwater or downstream side of the structure.

Fast moving weather systems or local convective activity producing large

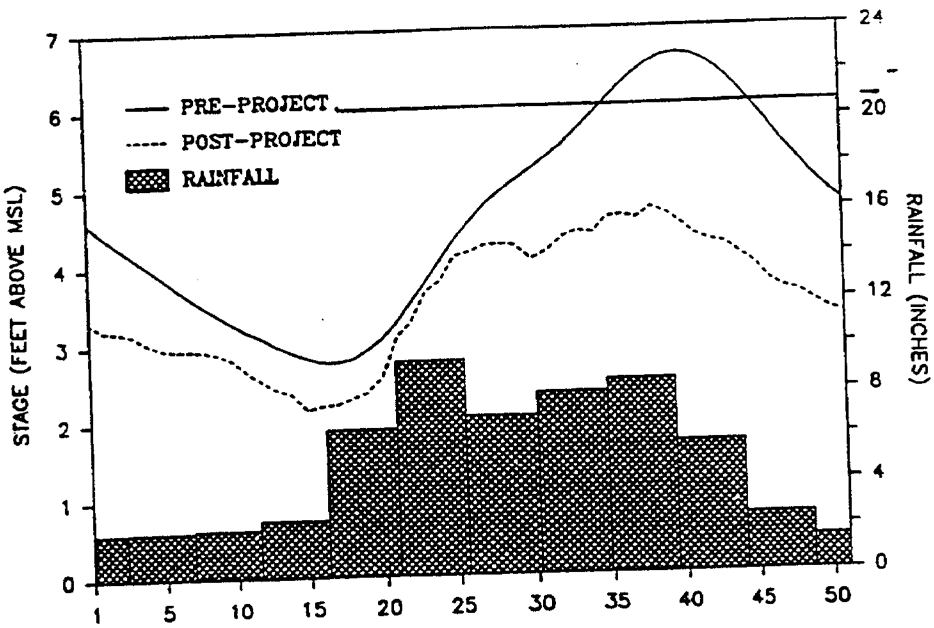


Figure 5: Pre- and Post-C&SF Project Stages at G-789

rainfall of relative short duration, *e.g.*, the 10-year, 1-Day rainfall, will bring stages to 6.91 ft. at G-789 (Table 1). Storms of this nature produce surface water ponding which rapidly infiltrates. Proper local drainage in the form of retention areas, perhaps in the form of ditches, rapidly draw this excess surface water and decreases the likelihood of crop damage from excessive ponding. Slow moving systems bringing storms of larger duration, *e.g.*, the 10-year, 7-Day storm has maximum stages at G-789 at 6.03 ft. These storms generally are of reduced intensity and rainfall rates rarely exceed infiltration and runoff rates over most of the area.

Even though the wet rainfall season is generally over by late October, the highest ground and surface water levels of the year generally do not occur until this time or in the first few weeks of the dry season. This is illustrated in Fig. 5 as a curve of typical pre-project ground water water levels at G-789, a stage recorder near S-176, and a bar graph of the typical annual rainfall distribution for the area. Note that the peak water levels occur in mid-October, well after the peak of the rainfall in September.

A comparison of maximum water levels with historical and SFWMM-1x1 data in the canal and at the monitoring points determines the existing and proposed flood protection at the given sites. An example of flood protection levels for the monitoring station G-789, located just east of L-31N, near S-176 is shown in Fig. 5. The authorized 10-year, 7-day storm water level for this station is shown on the graph, along with pre-project and post-project values. The pre-project values are based on the estimated average weekly stage at G-789 for the period from 1933 through 1947, using the methodology described in [Lent and Johnson, 1993b]. The post-project values represent the actual average weekly stages at G-789 based on the observed record for the period from 1965 through 1989, which coincides with the model simulation period. Average water levels at the peak of the wet season (week 40) are more than two feet lower under the post-project conditions. Average wet season water levels remain about two feet 1.5 ft. below the 1 in 10 year flood protection level. Under the pre-project conditions, average wet season water levels remained above 5.5 ft. from mid-august to early december. In contrast under post-project conditions average wet season water levels never exceeded 5.0 ft. and were more than 4.5 ft. for only 5 weeks. This is suprising, since G-789 is situated next to S-176 and the authorized optimum wet season water level is supposed to be 5.5 ft.

Current flood control operations of the C&SF Project during the peak rainfall months require reduced canal water levels which forces the removal of large quantities of water from the system. The historical peak water levels, which are a result of the natural slow release of rainfall generated storage of surface and ground water, which lagged well behind the end of the rainy season. This loss of water during the wet season causes the marsh to dry down more rapidly. This is further aggravated by the recent demands for agricultural drainage during this period. The acceleration of the canal wet season drawdowns has profound hydrological effects lasting well into the early spring. With the loss of substantial quantities of ground water, early spring rains must fill the subsurface first, greatly delaying the presence of surface water.

The loss of water storage near the surface and the accompanying deep drawdowns affect the aquatic communities in the marshes. The emptying of the near-surface solution cavities eliminates most of the aquatic productivity [Loftus *et al.*, 1992] and delays the build-up of adequate standing stocks of small fish and invertebrates. Thus, the effects of persistent wet season drawdowns, while lasting for a single year, can have ecological effects that carry over for several years.

4 Modeling

The 1x1 version of the South Florida Water Management Model (SFWMM-1x1, version 1.2) was used to aid in the evaluation of the proposed alternatives. This model simulates the hydrology south of Tamiami Trail and includes the majority of the freshwater wetlands of Everglades National Park (Fig. 6). The model incorporates all of the principal hydrologic processes and is primarily driven by rainfall and surface water inputs, obtained from the 2x2 version, along Tamiami Trail. These flows are input either into the canal system or directly into the wetlands. Surface water and ground water flows are modeled along with canal discharges, evapotranspiration and infiltration. A rough calibration and verification was carried out by the SFWMD, Lower District Planning Department, as part of the GRR process.

The model area is divided into 47 rows and 73 columns for a total of 3431 grid cells, each one mile by one mile. The actual model domain consists of 1557 cells, for a total of 1557 mi^2 (see Fig. 6). The northern boundary follows along Tamiami Trail, a convenient boundary, since known canal and structure operations may be input directly. All of the C&SF Project features that lie within the model domain are simulated, as well as ground and surface water flows.

Rainfall drives the hydrology in South Florida and thus the model. A standard simulation run is made by using the historical 25-year rainfall record, from 1965 to 1989. The SFWMM-1x1 uses 13 rainfall basins for input(Fig. 7). Annual, wet and dry season totals for the period of record used in the model are given in Table 2. A typical seasonal variation of the annual rainfall is shown in Fig. 8 for rainfall basin 7. To aid the selection of the dry and wet season seasonal subseries of the rainfall basins were used. The dry season months, November through April, receive about 20% of the total precipitation. The remaining months, May through October, constitute the wet season months. To present the information produced by the model for average, wet and dry conditions an evaluation of the 25-year rainfall record was conducted. This analysis defined the seasons and years which could best be used to represent the spectrum of hydrologic conditions in the basin. The years chosen for this analysis are

— Average: Water year November 1976 through October 1977.

— Wet: Water year November 1968 through October 1969.

— Dry: Water year November 1973 through October 1974.

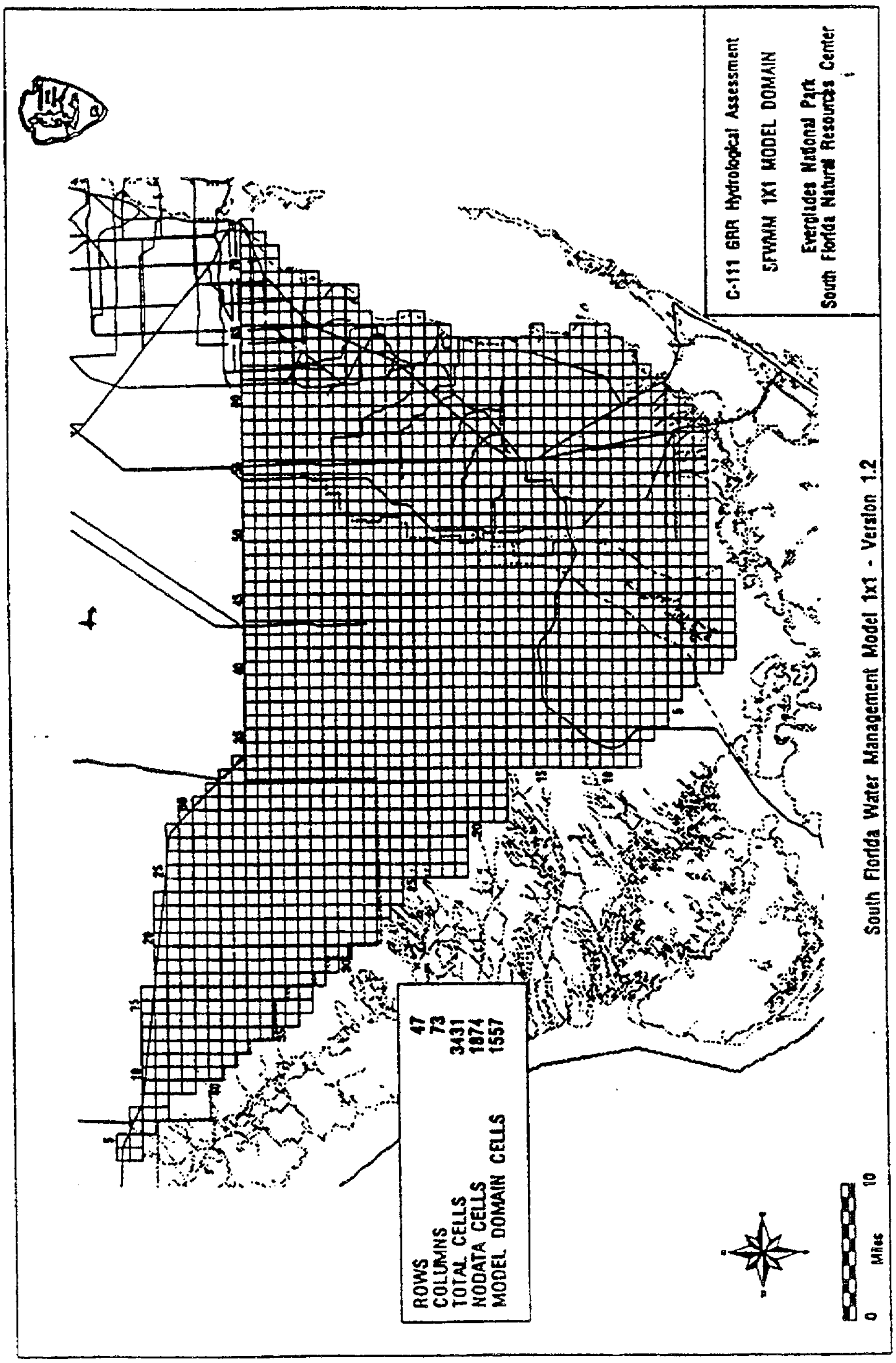


Figure 6: Modeling Domain.

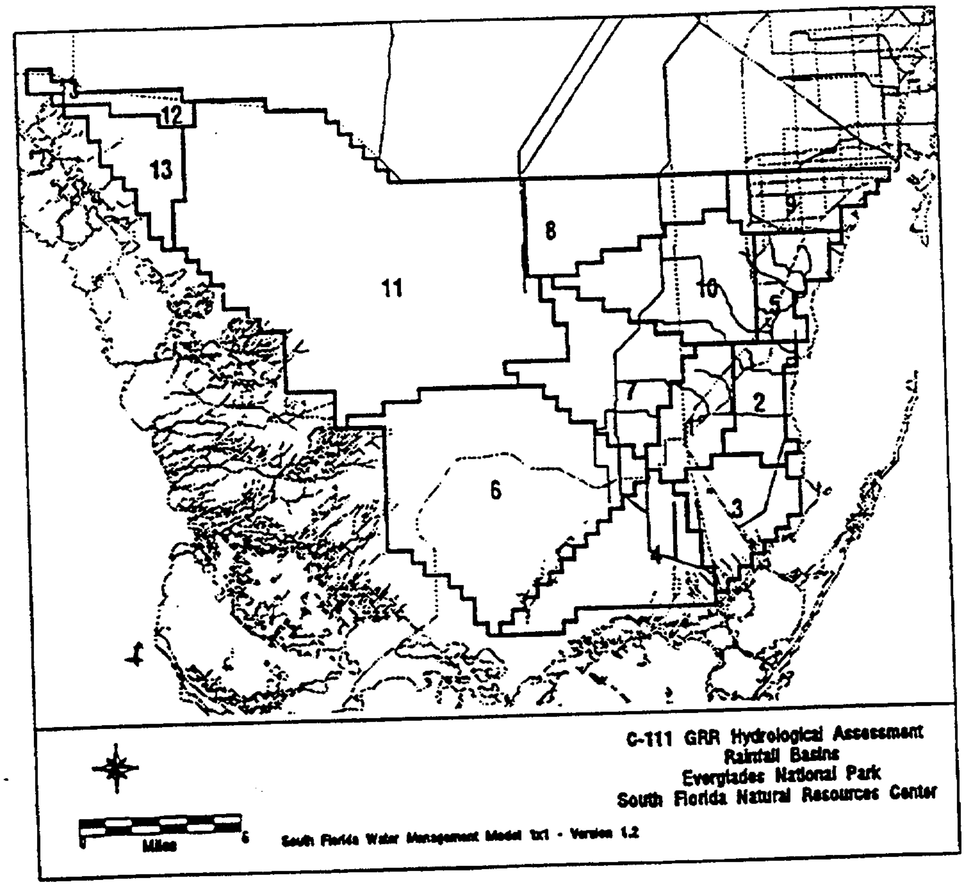


Figure 7: SFWMM–1x1 Rainfall Basins.

End-of-month values, monthly averages as well as daily information produced by the model for these specific years and 25–year averages of the output values, were used to present the results of the model runs. Water years are used in many instances to present the data from the beginnning of the specific dry season through the end of the specific wet season.

Other hydrologic processes simulated in the model are more specific. An important consequence of the canal system in South Florida is the large levee seepage from the marsh. For example, the levee adjacent to L-31N is simulated in two segments from S-335, at Tamiami Trail and L-31N intersection, southward to S-176, located at the north end of the Frog Pond. Under Base conditions seepage volumes through the levee from the wetlands west of L-31N average over 225,000 acre-feet per year. The large structures, the S-12's, supplying flows to Shark Slough deliver on the average 550,000 acre-feet per year

Rainfall Total in Inches							
Basin	Annual	Wet Season	Dry Season	Basin	Annual	Wet Season	Dry Season
1	56.0	44.0	12.0	8	48.0	38.0	10.0
2	44.0	33.0	11.0	9	57.0	43.0	14.0
3	41.0	31.0	10.0	10	56.0	43.0	13.0
4	44.0	34.0	10.0	11	46.0	36.0	10.0
5	51.0	38.0	13.0	12	58.0	47.0	11.0
6	55.0	44.0	11.0	13	50.0	41.0	9.2
7	57.0	45.0	12.0	Ave.	51.0	40.0	11.0

Table 2: Rainfall Means for SFWMM-1x1 Basins.

under the current operational schedules.

All of the processes are based on physical parameters provided through input. Infiltration of the surface to the ground water regime and the very important process of evapotranspiration are also modeled as part of the hydrologic system. Many of the parameters are assigned values obtained through field experiments and some of these are adjusted during the calibration process. Ground water is simulated as a two-dimensional single aquifer. A single layer is used, because all of the important water resources issues occur in the surficial aquifer. Wellfields in the developed areas are included in this portion of the model. A total of 199.9 MGD (223,888 AFY) is withdrawn from the Biscayne aquifer, including withdrawals made by two wellfields in west Dade, pumping a total of 40 MGD. Overland flow in the wetlands is also modeled as a two-dimensional process. Canals discharge into the adjacent grid cells, where the overland flow routine computes the exchange with the downstream cells.

Output from the model can be specified in many different forms. For the analysis contained herein, end-of-month values of water levels were used for illustrating the spatial surface water patterns. Daily water levels data was used to compute average monthly values for use in the analysis at the monitoring point locations. These daily values were also used to compute the hydroperiods. Total monthly flow data was used for all the canal and structure flows, and also for the analysis of the flowline data.

In order to evaluate the model's output of each of the alternatives for restoration benefit, it is desirable to compare the results against pre-drainage hydrology. No compatable 1x1 natural system version of the 1x1 SFWMM exists as it does for the 2x2 version. The incompatability of the grid size

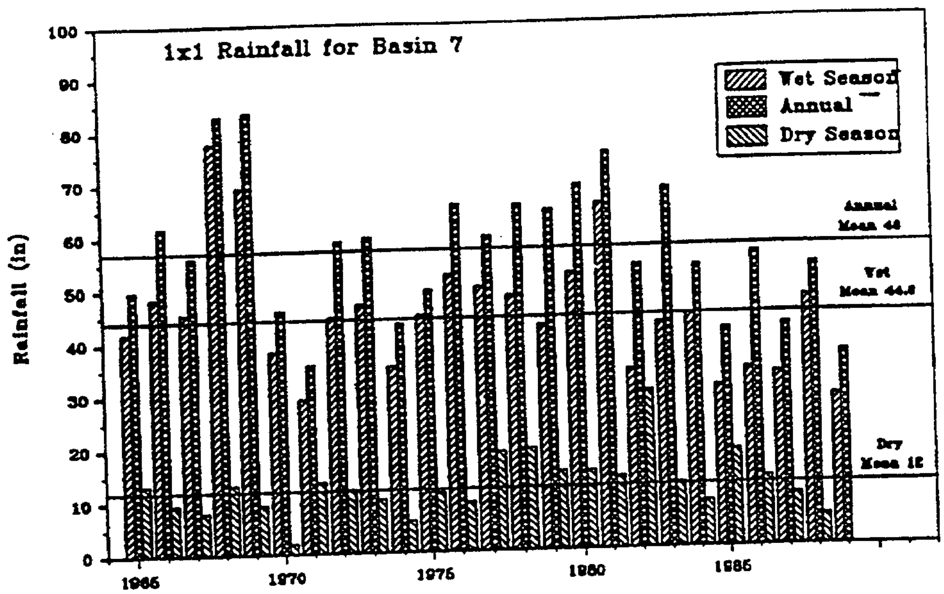


Figure 8: Total and Seasonal Variation for Rainfall Basin Number 7.

between the 2x2 version of the Natural System Model and the different rainfall basins, boundaries and model domain, did not warrant the effort to make comparisons between the two models.

5 Flow and Stage Comparisons in the L-31N, L-31W and C-111 Canals

A key feature of the GRR structural improvements is the provision to return to authorized canal and control structure operations. This is a critical element of the GRR since current water management operations of the relevant structures (Fig. 9) in the L-31N, L-31W, and C-111 canals cause over-drainage of the adjacent marshes, and allow large volumes of wet season runoff to be routed from one drainage basin into another. With the implementation of the Modified Water Deliveries improvements in the East Everglades wet season pumping at S-331 will be terminated. The southern L-31N basin (the reach between S-331 and S-176) traverses the Rocky Glades, which are the headwaters of the Taylor Slough basin. Appendix B, a separate volume to this report, provides the complete set of average monthly canal water levels for all of the alternatives.

5.1 L-31N Flow and Stage Comparisons

Fig. 10 shows the computed discharges through S-174 and S-176 under the base condition, for the 1980 through 1989 period. Note that all of the wet season outflows from the L-31N canal are passed through S-174. In contrast, flows through S-176 are limited to dry season deliveries, except during the high rainfall period in August and September of 1981. This indicates that simply returning to the authorized canal stages and operations would allow the majority of the wet season runoff to be redirected back into the Taylor Slough basin, rather than being dumped into the lower C-111 basin. This same pattern of redirecting L-31N outflows into the Taylor Slough basin via S-174 is maintained in all of the proposed structural alternatives.

A problem with inter-basin transfers of water continues to occur under the Base condition and one of the alternatives. Fig. 11 shows the estimated discharges through S-194 and S-196 under the Base condition and Alternatives 1 and 4, for the period 1980 through 1989. This graph indicates that significant volumes of wet season runoff are released eastward through the C-102 and C-103 canals under the Base condition and Alternative 1. This is contrary to the original design of the south Dade canal system, which was to pass excess water from the western portion of the Atlantic Coastal Ridge, westward into Taylor Slough [U.S. Army Corps of Engineers, 1963b]. This problem is substantially reduced (during all years except 1981) under Alternatives 2 through 6, which

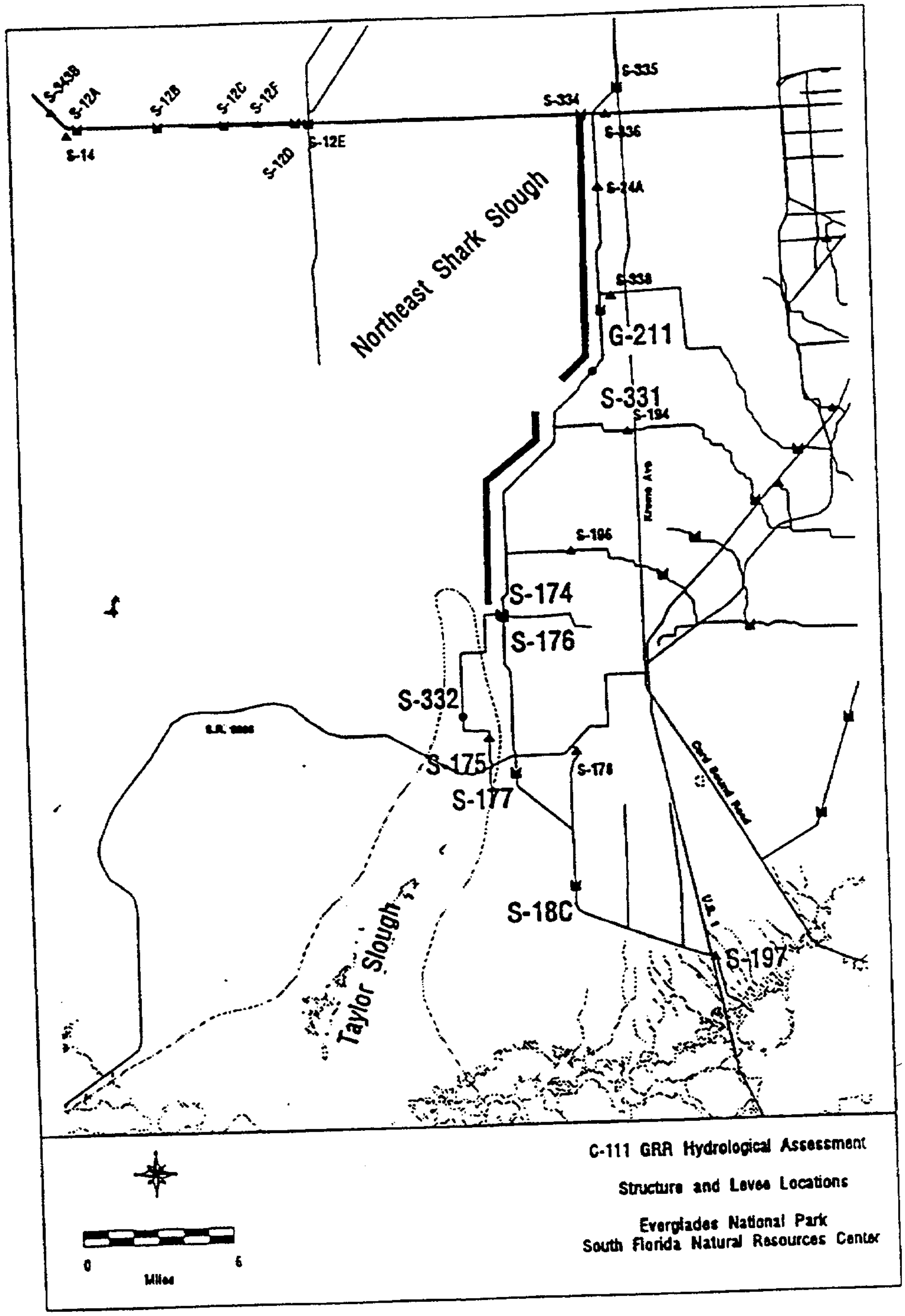


Figure 9: Selected structures in the L-31N, L-31W and C-111 Canals.

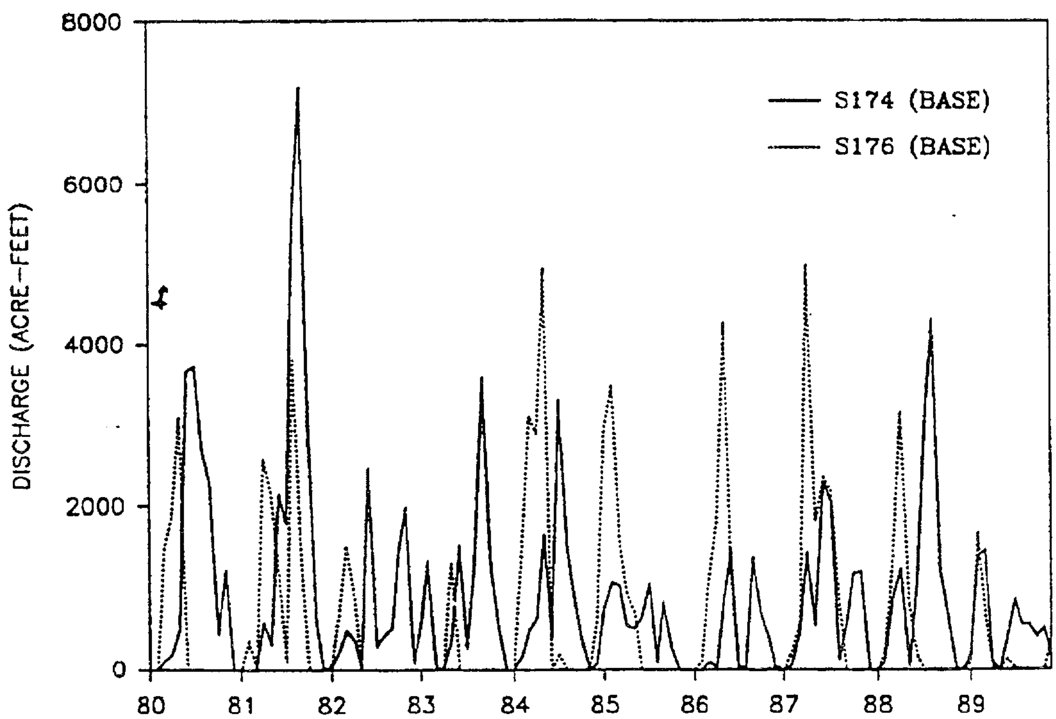


Figure 10: Discharges through S-174 and S-176.

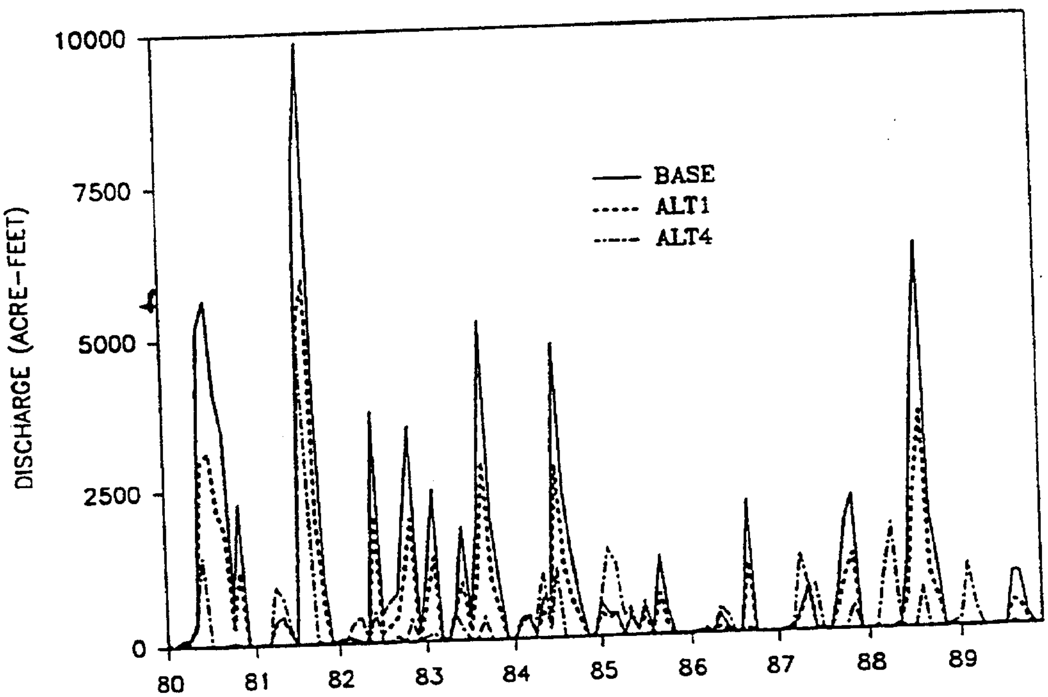


Figure 11: Discharges through S-194 and S-196.

redirect these flows westward into Taylor Slough. These alternatives reduce the eastern diversion of flows from the Taylor Slough headwaters, but they do not address the loss of surface water flows from the original contributing areas east of the L-31N canal.

Fig. 12 shows the estimated average monthly stage in the L-31N canal upstream of S-176, under the Base condition and Alternatives 4 and 5. The monthly averages were calculated based on canal water level data for the entire 25 year simulation period. We plotted only two of the alternatives, but all of the proposed structural plans substantially lower wet season canal water levels well below the Base condition, particularly during the period from August through October. Fig. 13 compares the estimated discharges out of the L-31N canal system and into Taylor Slough using a single large pump (such as in Alternatives 2, 3 and 5) versus a multiple pumping approach (such as in Alternatives 4 and 6). The multiple pump approach maintained S-176 headwater stages slightly higher, reducing the L-31N average wet season outflows by approximately 20,000 acre-feet per year. This means that more of the wet season runoff was retained in the adjacent marshes, rather then being drained into the L-31N canal and then pumped back into Taylor Slough. Multiple outflow pumps have the added advantage of allowing fine-tuning of the L-31N canal stages throughout the canal reach, and distributing marsh inflows over a broader front.

5.2 L-31W Flow and Stage Comparisons

Fig. 14 shows the estimated discharges into the L-31W canal under the Base condition and Alternatives 1 and 5. Alternatives 1 and 5 both include the addition of a new 1000 cfs pump station to convey flows westward into Taylor Slough, but the pumps are located at the site of the existing S-332 pump and adjacent to S-174, respectively. Note that the Base condition diverts, on average approximately 21,000 acre-feet of wet season runoff from the L-31N canal westward into the L-31W canal. Alternative 1 generally diverts only slightly more wet season runoff from the L-31N basin than the Base condition (approximately 25,000 acre-feet). In contrast, Alternative 5 diverts on average, more than 2.5 times the volume of the base condition (approximately 54,000 acre-feet). Unfortunately this is accomplished by substantially lowering L-31N canal water levels throughout the wet season. Since S-331 remains closed throughout the wet season, the majority of this excess runoff is the result of seepage losses from the drainage of the Rocky Glades wetlands into the L-31N canal.

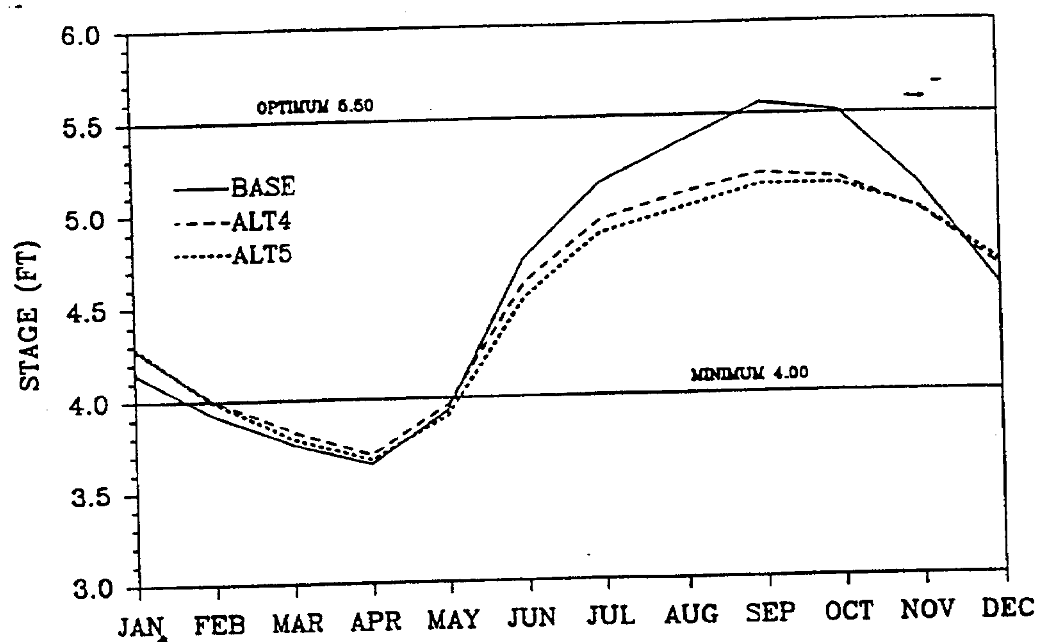


Figure 12: Average Monthly Canal Water Levels at S-176

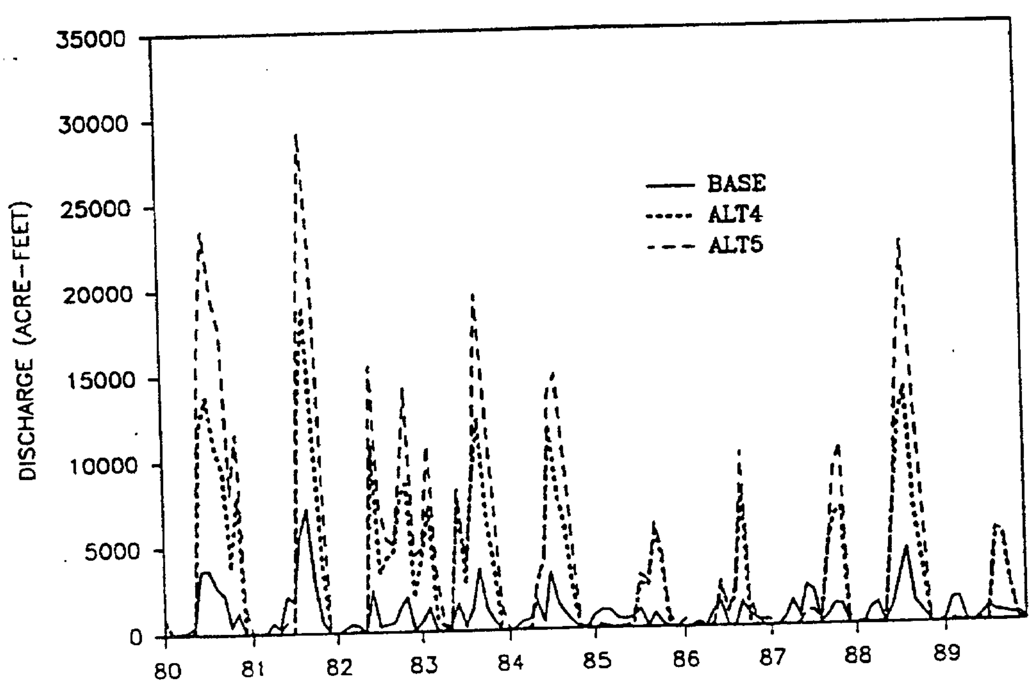


Figure 13: Discharges out off L-31N

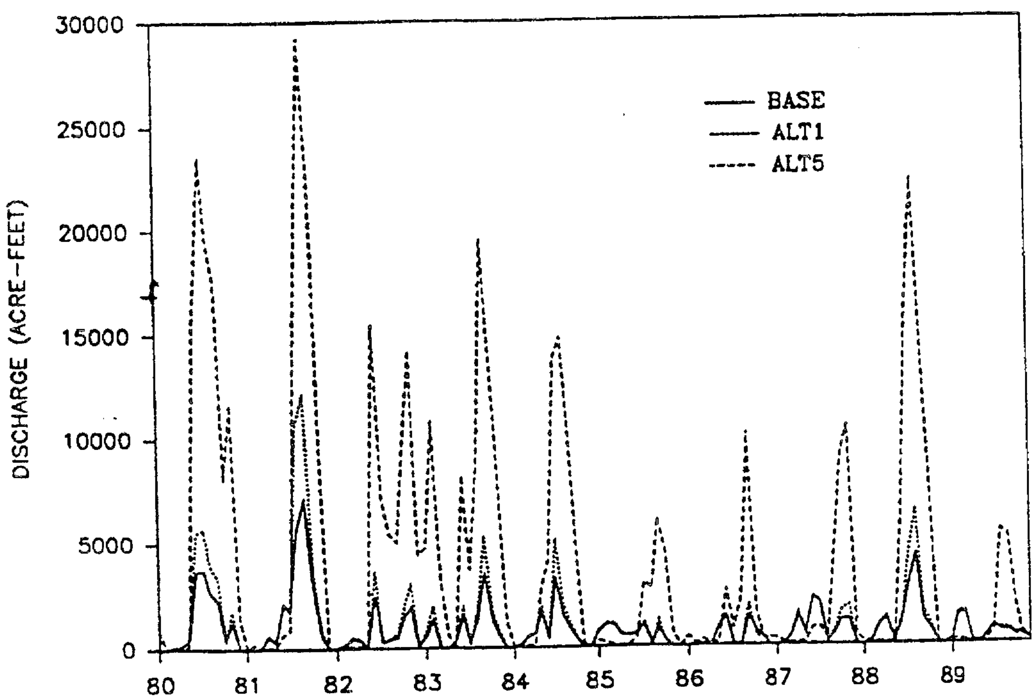


Figure 14: Discharges into L-31W via S-174.

5.3 C-111 Flow/Stage Comparisons

As stated earlier, S-176 is essentially not used to pass wet season runoff southward into the C-111 basin under the Base condition, or any of the alternatives. Small dry season inflows are provided to the C-111 basin for water supply. Fig. 15 shows the estimated discharges through S-177 under the base condition and three of the alternatives for the period from 1980 through 1989. The modeling results are highly variable, but they indicate that during most years, discharges are made through S-177 into the lower C-111 basin, with large flows occuring during high wet season rainfall periods such as 1981 and 1989. Under the Base condition and Alternatives 1, 2, and 6 average wet season outflows through S-177 averaged between 5,300 and 8,500 acre-feet. In contrast, average wet season flows through S-177 average between 11,000 and 18,400 acre-feet under Alternatives 3, 4, and 5. This increase is a result of the addition of a 500 cfs pump at the C500E spreader canal. Average monthly canal water levels for the C-111 canal upstream of S-177 are provided in Fig. 16. Alternatives 4 and 6 tend to lower average wet season water levels because most of the excess L-31N runoff is pumped into the marshes north of the Frog Pond. In contrast, Alternatives 2, 3, and 5 pass the excess L-31N runoff into Taylor Slough through a degraded L-31W canal or via the Frog Pond. This causes water levels to increase in the eastern portion of the Frog Pond, which contibutes groundwater seepage back into the C-111 canal, and maintains higher S-177 water levels.

Fig. 17 shows the estimated discharges through S-18C into the lower C-111 basin and the discharges through the new S-332B/C pump station at the C500E spreader canal for Alternatives 1 and 5. Under Alternative 1 the S-332C pump is limited to 50 cfs, so the discharges remain small, and all excess runoff is passed through the existing S-18C structure. Under Alternative 5 the S-332B pump is increased to 500 cfs, so the discharges are large, and additional outflows are provided by S-18C, which releases flows into the partially backfilled C-111 canal. Annual wet season outflows from the C-111 canal downstream of S-177 averaged between 14,400 and 18,300 acre-feet under the Base condition and Alternatives 1, 4, and 6. Average wet season outflows increased to between 20,000 and 25,000 under Alternatives 2, 3, and 5. This indicates that excess runoff from the C-111 basin can be effectively removed through the addition of the C-500E spreader canal and a large capacity pump. The use of a 50 cfs capacity pump will do little to remove excess wet season runoff, which means that the lower C-111 canal would have to be left intact.

A serious problem has been observed under the Base condition and all of the

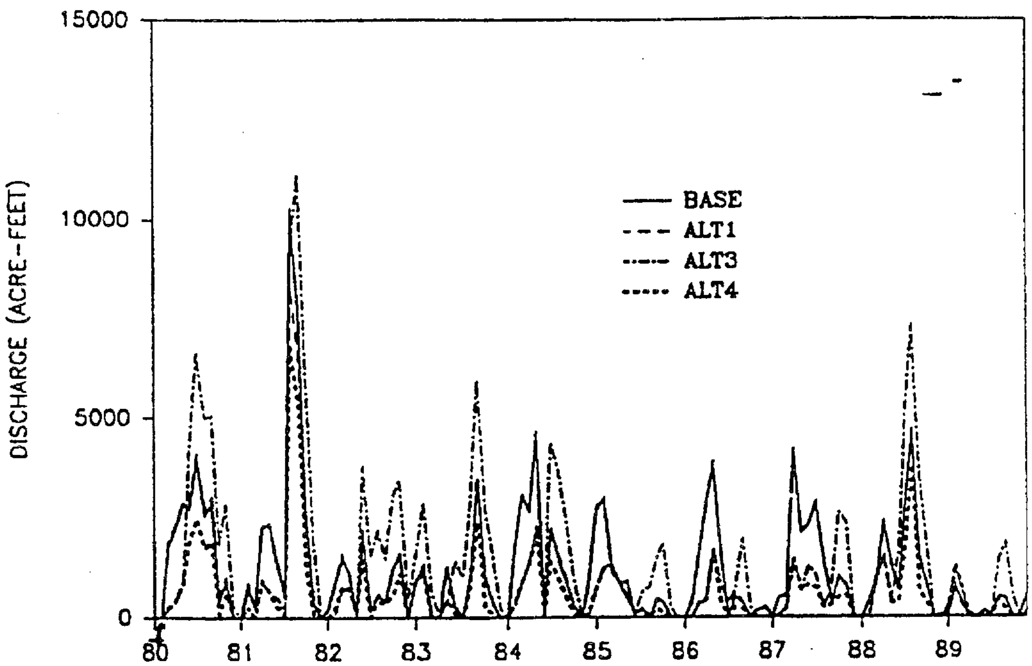


Figure 15: Discharges through S-177 into the Lower C-111 Basin

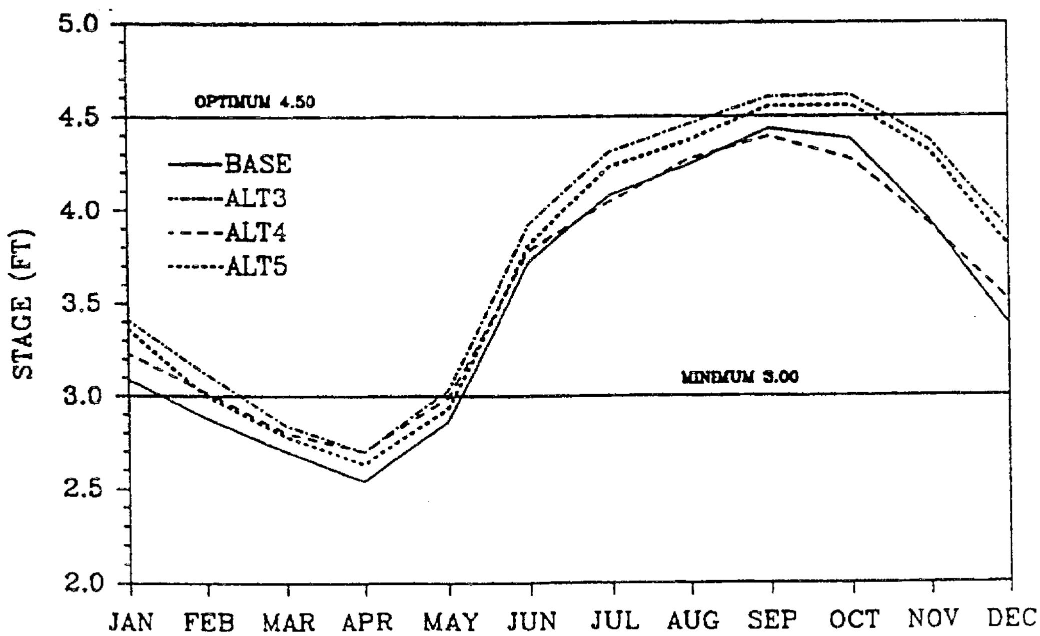


Figure 16: S-177 Headwater Stages

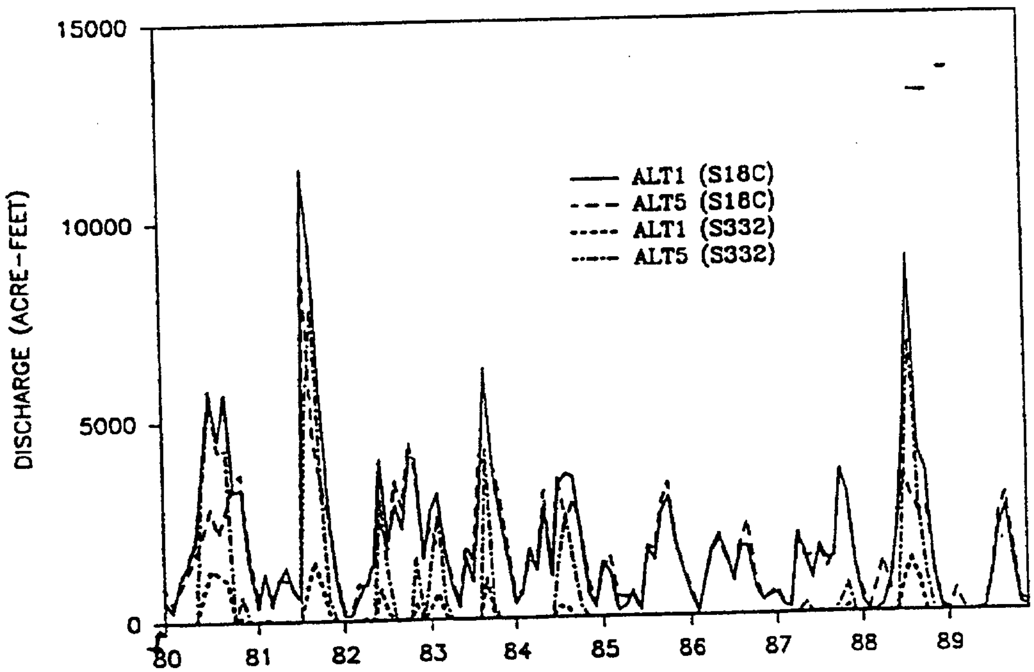


Figure 17: S-18C flows and S-332B/C

alternatives that leave the lower C-111 canal intact. Fig. 18 shows the annual total flows through S-197 under the Base condition and Alternatives 2 and 6 for the 25 year simulation. In these model runs large freshwater releases (some in excess of 30,000 acre-feet) are made through S-197 into Manatee Bay during the years with high wet season rainfall. These high flow periods are most conspicuous throughout the wet seasons of 1966, 1968, and 1969 and during August through November in 1981 and 1988. Rapid influxes of freshwater are known to have detrimental impacts on the downstream estuarine biota, and the need to discontinue S-197 releases has been a major driving force prompting the development of the C-111 GRR.

Fig. 19 shows the average monthly canal stage for the reach of the C-111 canal between S-177 and S-18C under the Base condition and Alternatives 3, 4, and 5. Alternatives 3 and 4 tend to raise wet season canal water levels, while Alternatives 1, 2, 5, and 6 show only minor differences from the Base condition. This suggests that alternatives that discharge excess L-31N runoff into Taylor Slough at locations as far south as S-175 have a high likelyhood of loosing much of this water as groundwater return flow to the C-111 canal downstream of S-177. The Park has suspected that this happens under current

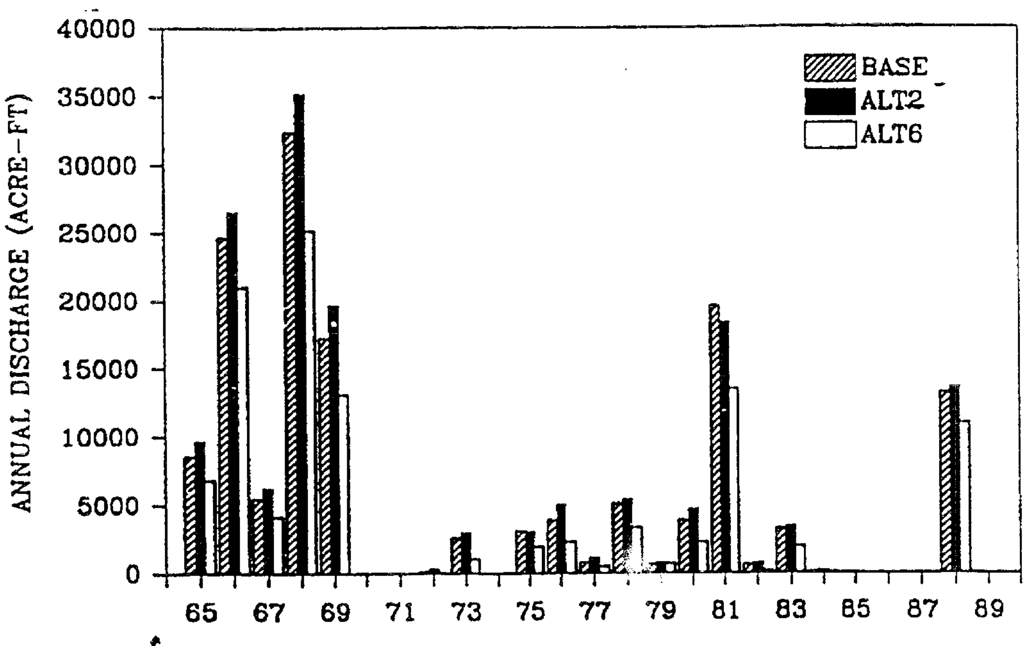


Figure 18: Annual Total Flows through S-197

operating conditions since canal stages downstream of S-177 are maintained several feet lower then the more natural marsh elevations in Taylor Slough downstream of S-175.

Fig. 20 shows the average monthly canal water levels in the C-500E spreader canal under the Base condition and Alternatives 1, 4, and 5. Alternatives 3, 4, and 5 include the new 500 cfs pump station, and have a significant impact on raising wet season canal water levels. In contrast, Alternatives 1, 2, and 6 add only a 50 cfs pump station which maintains wet season stages close to those under the Base condition. One disturbing problem is the extremely low water levels predicted at this location in the dry season. This indicates that the wet season stormwater inflows drain out of the system quickly, and supplemental dry season inflows are ineffective at maintaining wetland stages.

6 Water Budget Computations

A series of wet and dry season water budgets were calculated for the reaches of the L-31N and C-111 canals between S-331 and S-18C under the Base condition and the six proposed alternatives. In each case, all of the structure inflows and outflows for the specific canal reaches were calculated for the 1977 wet season,

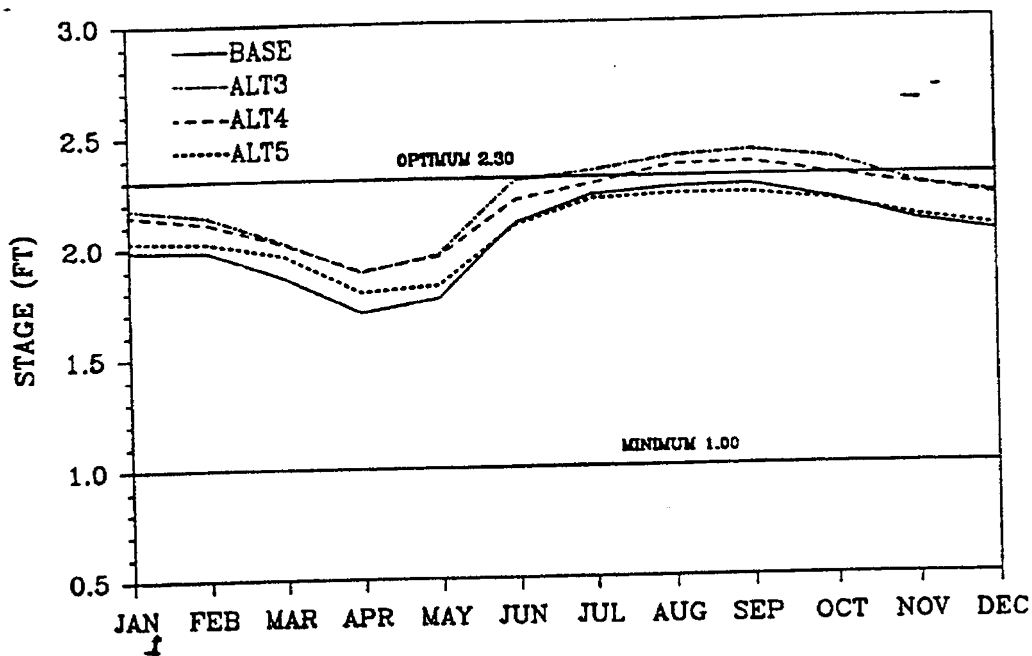


Figure 19: Average Monthly Canal Stage in Central C-111, between S-177 and S-18C

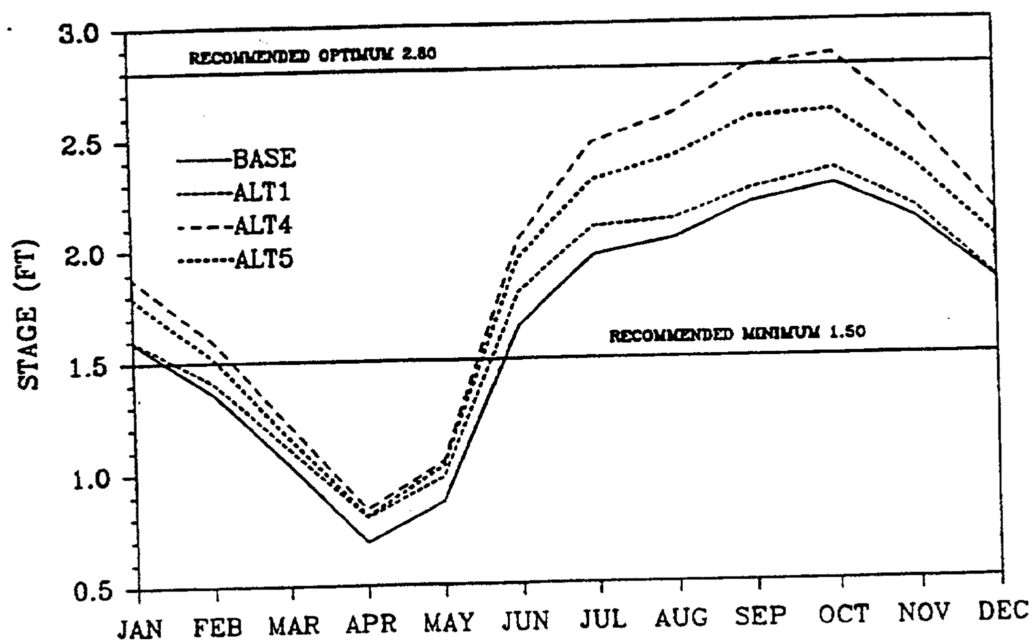


Figure 20: Average Monthly Canal Levels in C-500E

which represents an average rainfall period for the 25 year simulation. Inflows and outflows were included for the L-31W canal under the Base condition and Alternative 1, but the remaining alternatives significantly modified the canal system, making water budget estimates inappropriate.

6.1 Wet Season Water Budgets in the L-31N and C-111 basins

Figs. 21 and 22 show the wet season water budgets under the Base condition and the six proposed alternatives for the canal systems during the period from June through October, 1977. The numbers adjacent to each structure represent the total wet season discharges in acre-feet for each of the water control structures. For the entire 25-year simulation there were no wet season inflows into the L-31N canal via the S-331 pump station. Under the Base condition, L-31W outflows for the 1977 wet season were approximately 23,300 acre-feet. Of this total, 40 percent of the outflows were discharged into the L-31W canal via S-174, and the remaining 60 percent was discharged eastward via S-194 and S-196. As stated earlier, these eastward diversions are inconsistent with the original design of the south Dade canal system, and represent a significant loss of flows from the Taylor Slough basin. Note that Alternative 1 has similar eastern diversions, but the remaining alternatives virtually eliminate these eastward losses. Alternatives 2 through 6 significantly increase the wet season outflows from the L-31N canal system. Alternative 6 increases these outflows to more than 67,000 acre-feet. The increased outflows are the result of reductions in L-31N canal water levels, to stages well below the levels required to provide the authorized level of flood protection to the basin. The tables in Appendix B list the wet season inflows and outflows for the 25 year simulation period. During high rainfall years such as 1968 and 1969, Alternatives 2 through 6 drain tremendous volumes of runoff from the L-31N canal system. Alternative 5, in particular, drains more that 110,000 acre-feet from the L-31N canal system during each of the 1968 and 1969 wet seasons. This is more that 50,000 acre-feet in excess of the Base condition. Again the source of most of this water is the over-drainage of the marshes of the Rocky Glades.

The wet season water budget diagrams also show that in the upper C-111 canal (between S-176 and S-177) Alternatives 3, 4, and 5, have much higher wet season outflows during the 1977 average year. This is the result of a 500 cfs pump at the C500E spreader canal. Alternative 3 produces a three-fold increase in wet season outflows, largely in response to the seepage losses from the Frog Pond impoundment. This again suggests that structural plans that

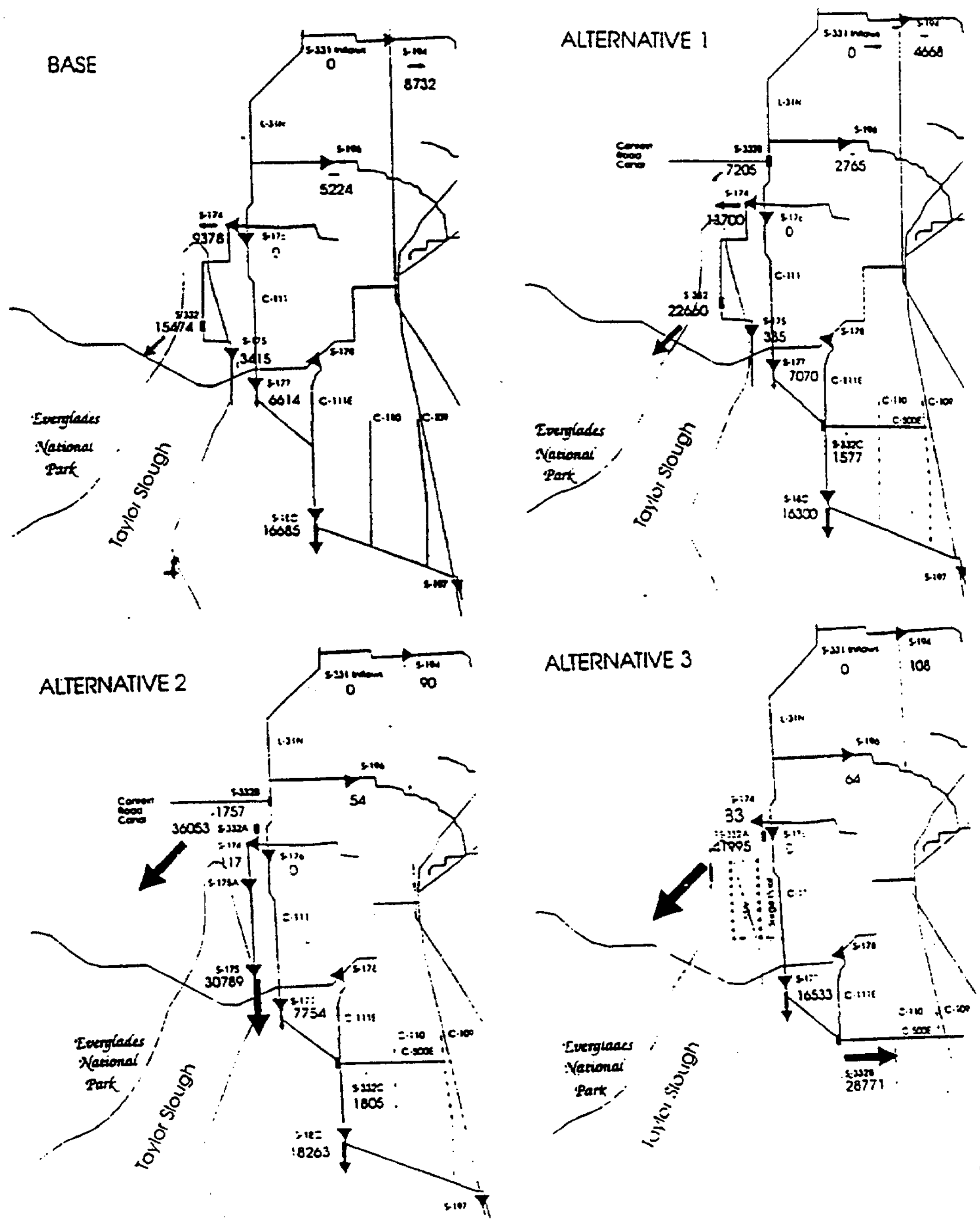


Figure 21: Wet Season Water Budgets for Base condition and Alternatives 1, 2 and 3

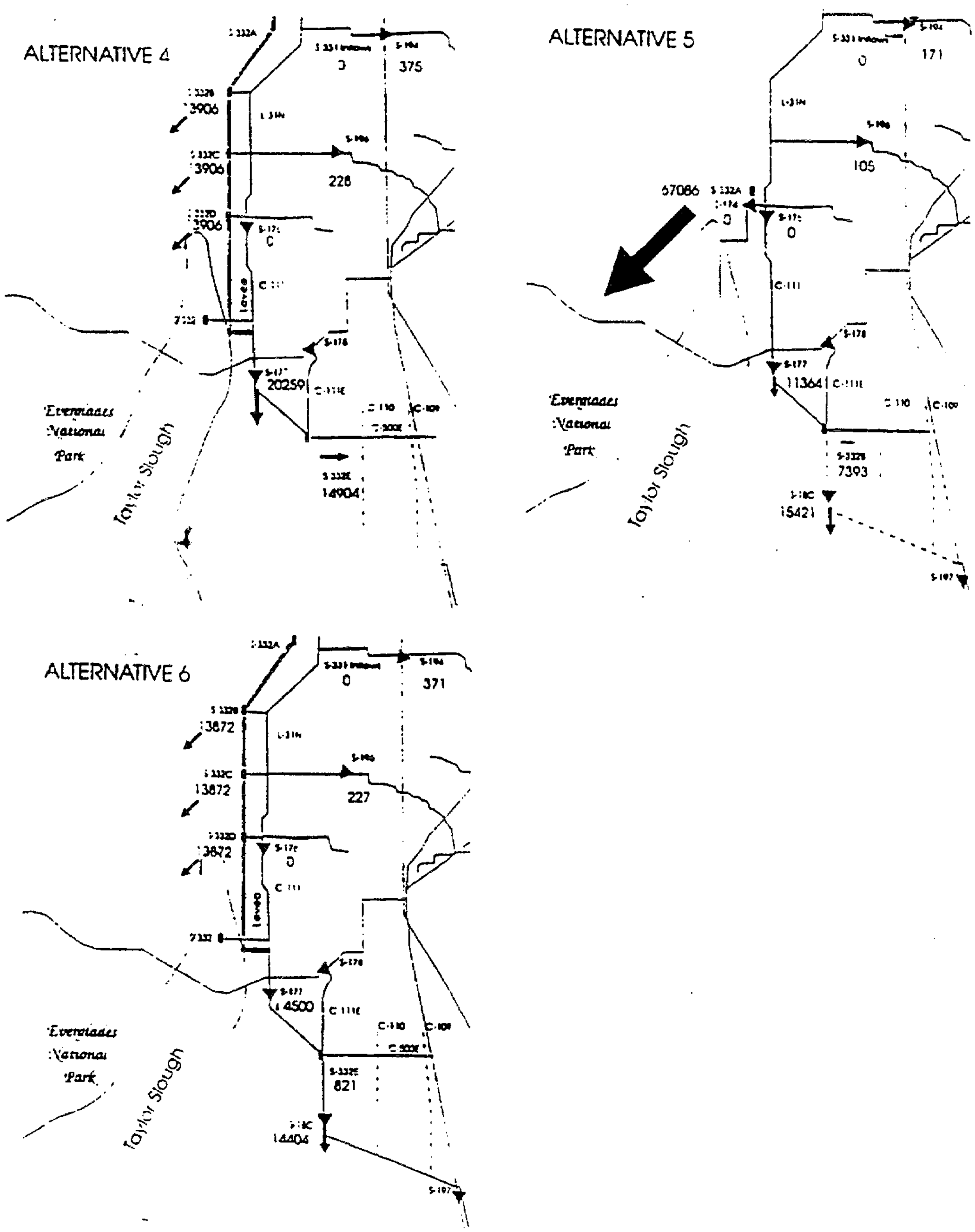


Figure 22: Wet Season Water Budgets for Alternatives 4, 5, 6.

remove the lower C-111 canal and replace the needed outflows with a large pump station and spreader canal provide an effective way of protecting the developed lands adjacent to the upper C-111 canal. The water budget for the middle reach of the C-111 canal (between S-177 and S-18C/S-332) also indicates that the proposed pump station and spreader canal can effectively drain this portion of the C-111 basin, as well as gravity releases through S-18C, without the risk of damaging freshwater outflows into Manatee Bay.

6.2 Dry Season Water Budgets in the L-31N and C-111 basins

Figs. 23 and 24 show the dry season water budgets under the Base condition and the six proposed alternatives for the canal systems during the period from November 1976 through May 1977. The numbers adjacent to each structure represent the total dry season discharges in acre-feet for each of the water control structures. Supplemental dry season pumping at S-331 provided just under 17,000 acre-feet to the L-31N basin under the Base condition. All of the alternatives had similar inflow volumes. For the 25 year simulation, dry season supplemental inflows averaged approximately 14,400 acre-feet, and peaked at just under 32,000 acre-feet in the dry season of 1971. These figures are incredibly low given the expected dry season supplemental water demands estimated by the Corps in their 1973 GDM for the South Dade Conveyance System (U.S. Army Corps of Engineers 1973). This report states that "pumping demands at S-331 are estimated at 264,800 acre-feet annually." The dry season supplemental pumping at S331 simulated in the model is approximately 5% of the Corps expected volumes. Clearly, the modeling has not captured the authorized operational practices of the SDCS.

These dry season inflows into the L-31W and C-111 canals are inadequate to meet the Congressionally mandated Minimum Delivery Schedule. Note that the required 38,000 acre-feet pumping at S-332 into the Taylor Slough basin essentially never occurs, and that inflows into the S-174 canal to support these required pumpages are never made. During the 1977 average year, outflows from the L-31W canal were more than double the inflows. For the 25 year simulation, the L-31W canal system under the Base condition produces a net loss of water from the Taylor Slough headwaters of approximately 11,000 acre-feet. This shows that the L-31W canal continues to be used to provide drainage for the Frog Pond, in violation of its design purpose. A review of the average dry season canal water levels in the L-31N and C-111 canals (Figs 12 through 19) show that the Base condition and all of the alternatives allow the

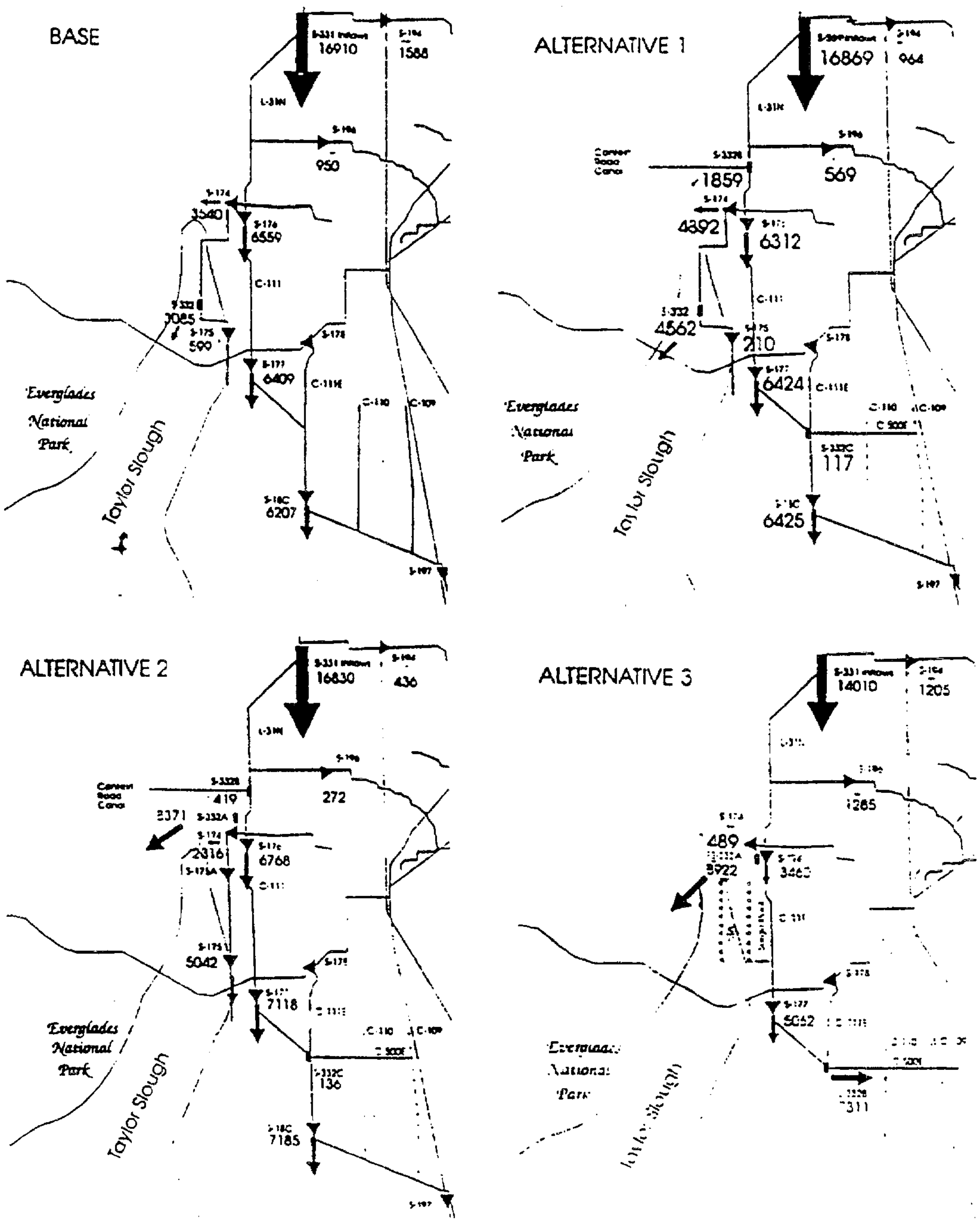


Figure 23: Dry Season Water Budgets for Base condition and Alternatives 1, 2 and 3

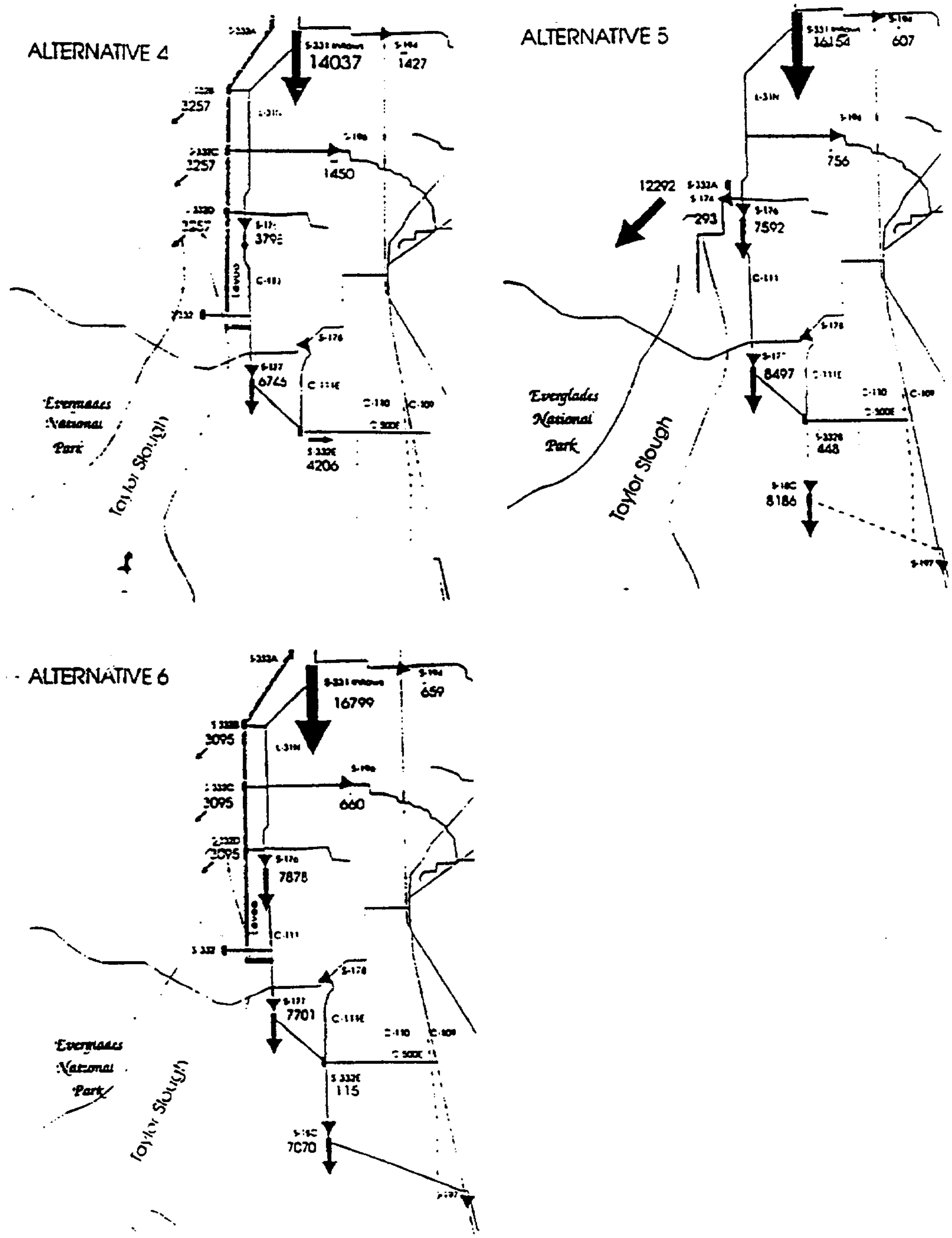


Figure 24: Dry Season Water Budgets for Alternatives 4, 5, 6.

canal stages to fall well below the dry season minimum stages established for the South Dade Conveyance System. This again is a reflection of the lack of dry season supplemental inflows from the upstream Water Conservation Areas.

7 Marsh Flowline Comparisons

A series of six flowlines were defined in each of the model runs to examine the potential impacts of the proposed alternatives on surface water and groundwater flows through the marshes of the Rocky Glades, Taylor Slough, and the Lower C-111 basin.

Fig. 25 shows the location of each of these flowlines, all but two of the lines are oriented east to west, to estimate the predominant north to south flow. The differences in total annual surface water and groundwater flows along each flowline for the Base condition and the six proposed alternatives were computed and are tabulated in the separate volume containing the appendix. Due to the lack of surface water during a large part of the year the groundwater flows made up slightly over 50% of the total annual flows in the over-drained marshes of the Rocky Glades, but the percentage decreased in the downstream direction, accounting for 10% or less at the marsh flowlines within southern portions of Taylor Slough and the Eastern Panhandle basins. Under average historical conditions in the C-111 basin, in places where there was persistent surface water, the ground water contribution to the water budget has been estimated to be about 10% of surface water flow. The contribution varies depending on the local transmissivity of the aquifer and the amount of surface water present through the year. For the Base condition and all of the alternatives, approximately 75% to 85% of the total annual surface water and groundwater flows occurred during the wet season, in response to local rainfall and flood control operations.

7.1 Flows through the Rocky Glades

Two flowlines were included in this area. The northern-most flowline (RCKGL) cuts across the central Rocky Glades, just south of the East Everglades. This flowline showed that no changes would be expected in the surface water and groundwater flows in this area. Under Alternatives 4 and 6, a 300 cfs pump station (S332A) is added at the southwest corner of the proposed East Everglades seepage control system. This caused ponding immediately downstream of the pump, which produced a slight reversal in surface water

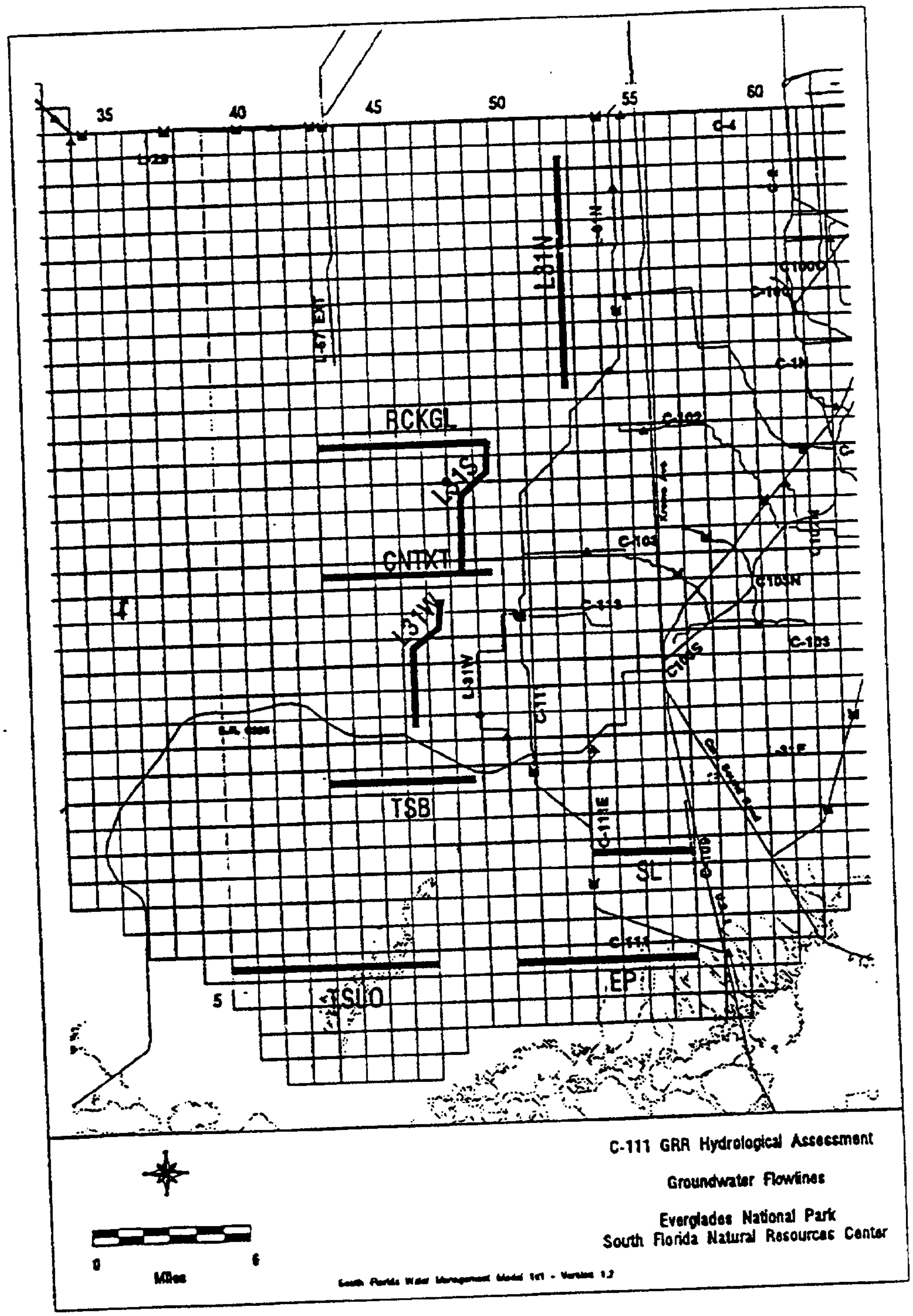


Figure 25: Flow line locations.

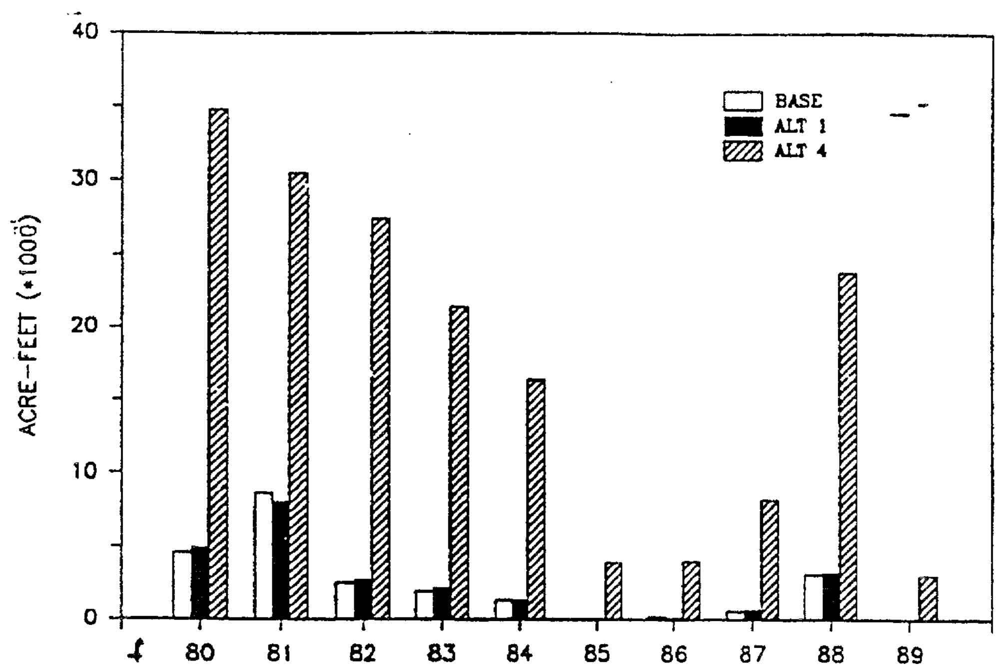


Figure 26: Surface Water Flows across the Context Road Flowline.

and groundwater flow directions. Flows in the southern portion of the Rocky Glades were examined at a flowline oriented along Context Road (CNTXT). Under the Base condition and Alternatives 1, 2, 3, and 5 groundwater flow is slightly greater than surface water flow, and all of the alternatives produced a slight reduction in flows. Fig. 26 shows the annual surface water flows for the Base and two of the alternatives for the period from 1980 through 1989. Under Alternatives 4 and 6, surface water flows were increased by an average of 19,000 acre-feet per year, and by more than 30,000 acre-feet during high rainfall years. These changes are a response to the direct marsh inflows from the S-332B and S-332C pump stations.

7.2 Flows through Taylor Slough

Two flowlines were included in this area. The first is located just south of the Taylor Slough Bridge flow-section (TSB) to allow later comparisons with the historical published flows. At this flowline groundwater flows accounted for approximately 30% of the total annual flows, and showed only minor changes in response to the proposed structural changes. Fig. 27 shows the annual surface

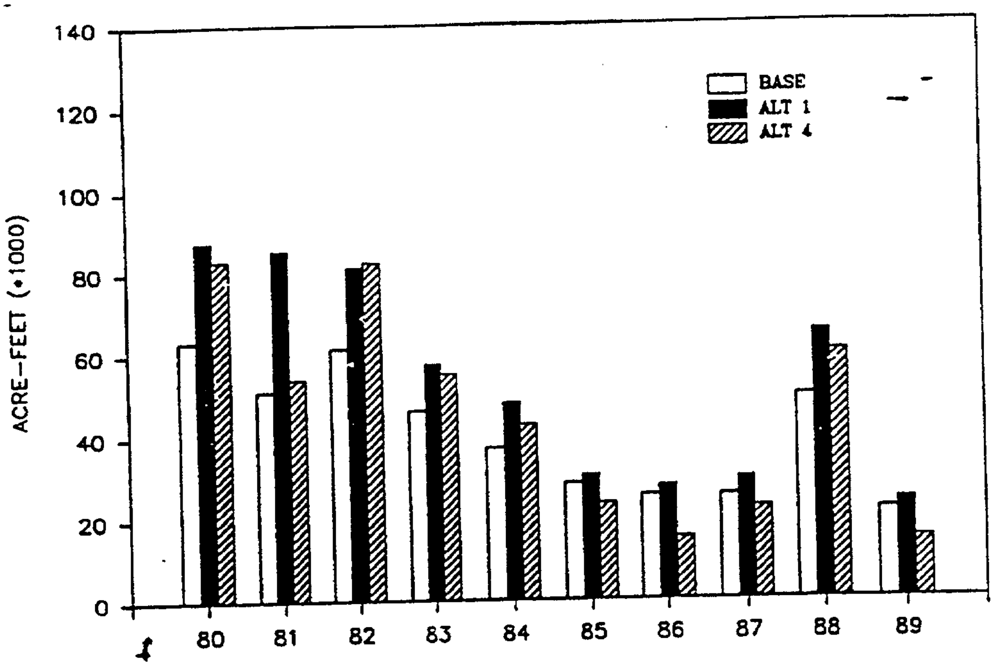


Figure 27: Annual Taylor Slough Bridge Surface Flows.

water flows for the Taylor Slough Bridge flowline under the Base condition and two of the alternatives, for the period from 1980 through 1989. Average annual surface water flows were approximately 44,000 acre-feet for the 25-year period under the base condition and increased slightly under all of the alternatives. Alternative 1 had the greatest impact, increasing average annual surface water flows by approximately 15,000 acre-feet. This is a response to the enlargement of the existing S-332 pump station proposed under this alternative. Fig. 28 shows the annual surface water flows at the southern Taylor Slough flowline for the Base and two of the alternatives, for the period from 1980 through 1989. Average annual surface water flows were approximately 69,000 acre-feet under the Base condition for the 25-year period, and all of the alternatives, except 3 and 5, produced a slight increase of up to 10%. Groundwater flow at this point contributed approximately 10% of the total annual flow, and none of the alternatives had a significant impact on flow volumes.

7.3 Flows through the Eastern Panhandle

Two flowlines were included in this area. The northern-most flowline is located in the State lands just south of the proposed C-500E spreader canal. The Base

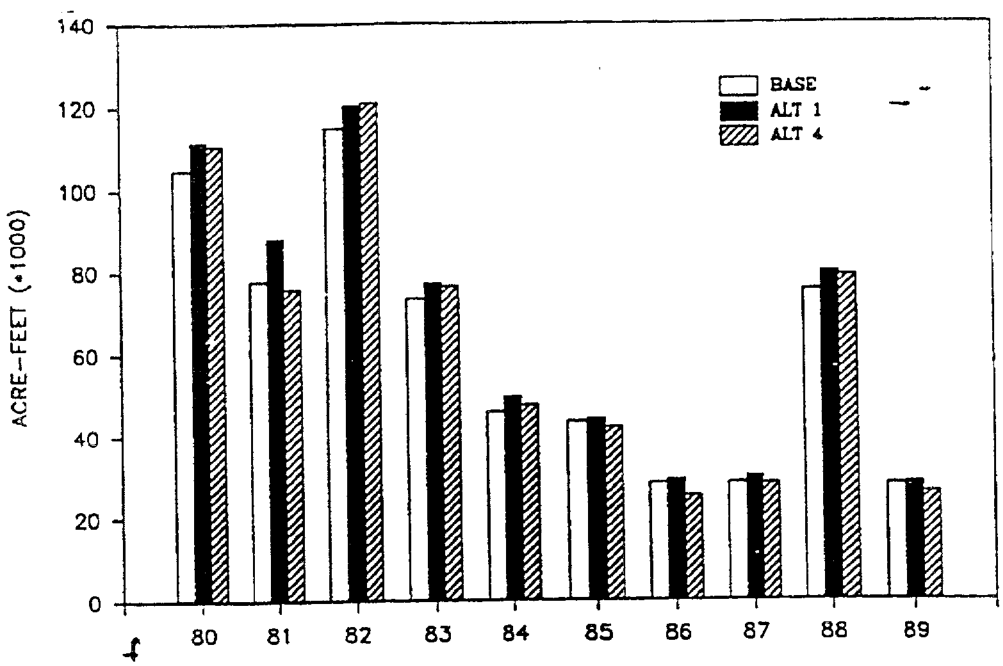


Figure 28: Annual Southern Taylor Slough Surface Flows.

condition suggests that surface water and groundwater flows in this area are insignificant. In contrast, surface water flows were increased significantly under all the alternatives, particularly Alternatives 3, 4 and 5, which proposed the installation of a 500 cfs pump station at the intersection of C-111E and the new C-500E canal. Fig. 29 shows the annual surface water flows for the flowline in the lower portion of the Eastern Panhandle basin under the Base condition and two of the alternatives, for the period from 1980 through 1989. At this flowline average annual surface water flows were approximately 74,000 acre-feet for the 25-year period under the Base condition, and increased by slightly more than 10% under Alternatives 3 and 5. Again, groundwater flow contributed approximately 10% of the total annual flow, and none of the alternatives had a significant impact on flow volumes.

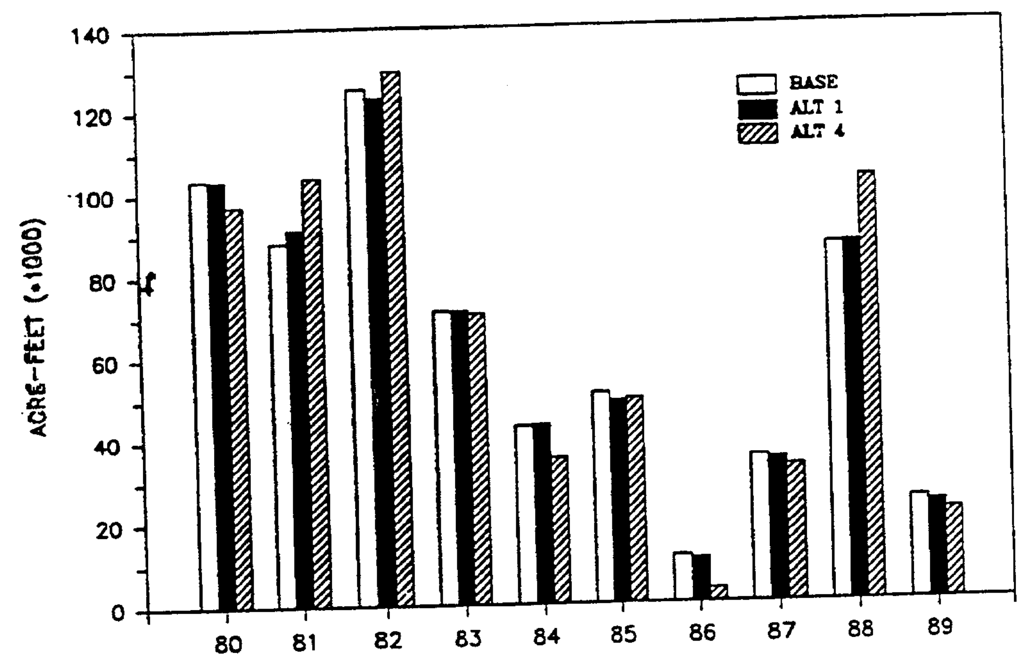


Figure 29: Annual Eastern Panhandle Surface Flows.

8 Stages and Hydroperiods at Selected Monitoring Points

Twenty-one grid cells were selected to examine the temporal water depth and hydroperiod characteristics of the Base condition and the six structural alternatives. These grid cells correspond to actual monitoring point locations (Fig. 30) which have actual water level recorders, so the model results could also be compared with actual data. This comparison will determine the level of calibration for the wetland stages. This analysis was not done for this report. Discrepancies often will occur since the modeled water level data represents a computed value assigned throughout the selected 1 mile by 1 mile grid cell, not the water level at a specific gage. The gage names will be used instead of the grid cell locations throughout this section of the report as a way of simplifying the nomenclature. For each grid cell, descriptive statistics were tabulated from the modeled daily water level data to define the wet and dry season attributes, and frequency analyses were tabulated to describe the flooding and drying characteristics. In addition, a series of water level hydrographs and stage exceedence curves were developed for a representative set of grid cells.

The preliminary modeling results prepared by the Corps of Engineers showed that the structural modifications could be expected to have their greatest effect on water levels in the marshes of the Rocky Glades, Taylor Slough, and lower C-111 basins, since these are the areas that would receive the excess stormwater runoff. Therefore, the water depth and hydroperiod analyses were designed to examine the potential hydrologic impacts of the proposed structural modifications for a set of five sub-regions dividing these and the developed areas.

a) Four grid cells were chosen to characterize the hydrologic conditions in the developed areas east of the L-31N and C-111 canals. These grid cells included one gage (G-855) east of Krome Avenue in the upper L-31N basin, two gages (S-196A and G-789) in the lower L-31N basin, and one gage (G-613) adjacent to the C-111E canal (Fig. 30).

b) Four grid cells were similarly chosen to characterize the hydrologic conditions in the 8.5 square mile residential area (G-596), and in the agricultural areas of the Rocky Glades (G-3437 and RUTZKE) and the Frog Pond (FROGP).

c) Three gages (G-3115, R-3110, and TSB) were selected to estimate the hydrologic impacts expected in the Rocky Glades and upper Taylor Slough.

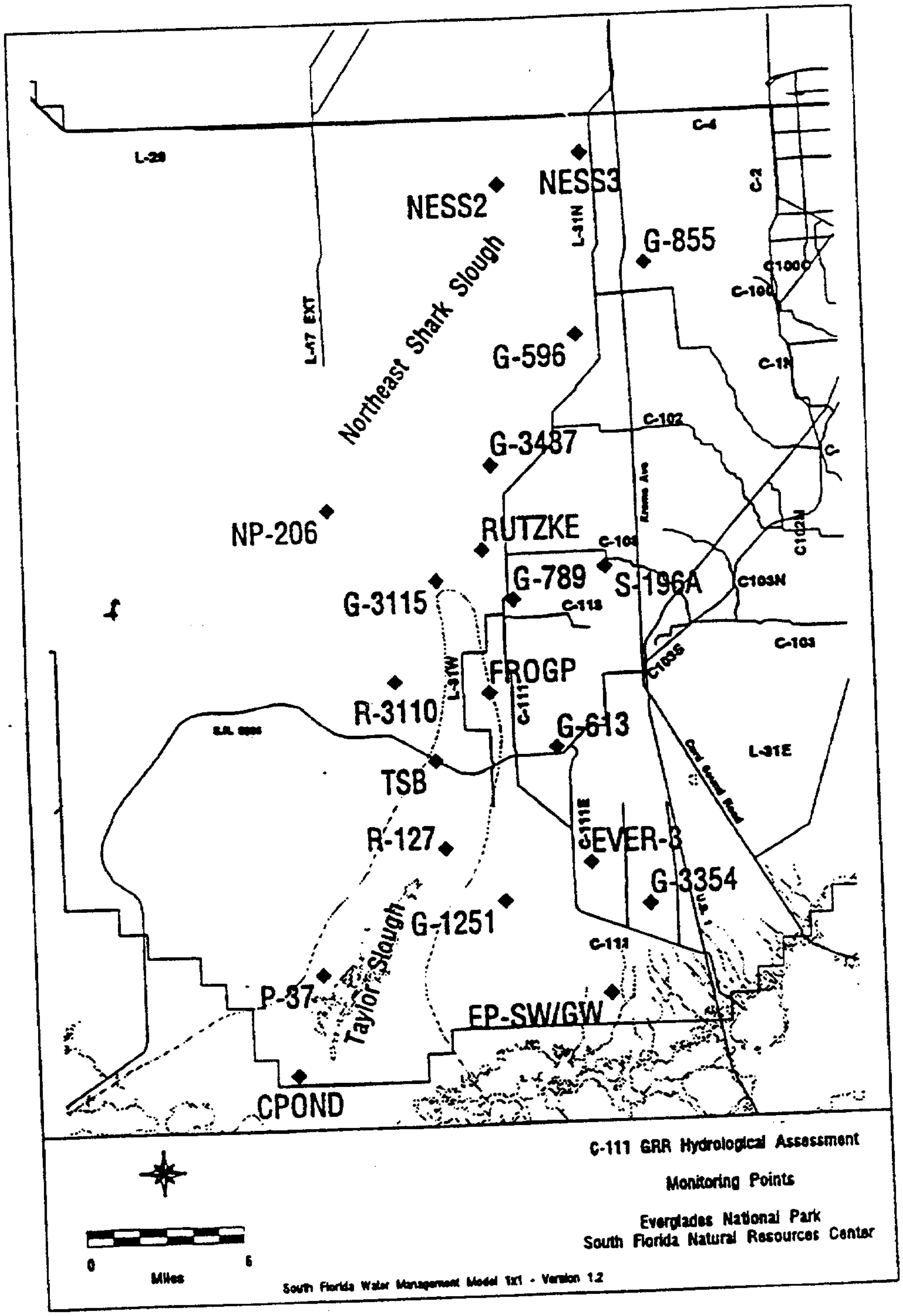


Figure 30: Selected Monitoring Point Locations

d) Three gages (R-127, P-37, and CPOND) were similarly selected to describe the estimated hydrologic changes expected in the lower Taylor Slough basin.

e) Four gages (EVER-3, G-3354, EP-SW/GW, and G-1251) were selected to characterize the expected changes in the wetlands adjacent to the lower C-111 canal.

The results of this analysis are described in the next five subsections. Hydrographs, stage exceedence curves, tables of descriptive statistics, and flooding/drying frequency tables for all of the selected grid cells in these sub-regions are included in the separate volume containing Appendix B.

8.1 Water Depth/Hydroperiod Impacts in the Eastern Developed Areas.

Fig. 31 shows the expected water level conditions at gage G-789 in the lower L-31N basin under the base and alternative plans. The hydrologic conditions at this site are typical of the conditions in the eastern developed areas. Note that water depths essentially always remained more than 1.5 feet below the ground surface at all four of the representative grid cells, throughout all of the model runs. Alternatives 2 through 6 tend to slightly lower the average monthly wet season water levels at G-855, S-196A, and G-789 during most years. This suggests that the increased outflow capacity provided by pumping directly out of the L-31N canal can provide a slight increase in the level of flood protection in these areas. At G-613 in the C-111E basin, wet season water levels tended to rise slightly (particularly under Alternatives 3 and 5).

8.2 Water Depth/Hydroperiod Impacts in the Western Developed Areas.

Fig. 32 shows the expected water level conditions at the RUTZKE gage in the Rocky Glades agricultural area, under the base and alternative plans. The hydrologic conditions at this site are typical of the conditions in the western urban and agricultural areas. Hydrographs, stage exceedence curves, tables of descriptive statistics, and flooding/drying frequency tables for all of the selected grid cells in this sub-region are included in the separate appendix. Note that water levels are highly variable in all of these areas, and that surface flooding would be expected to occur during periods of high wet season rainfall.

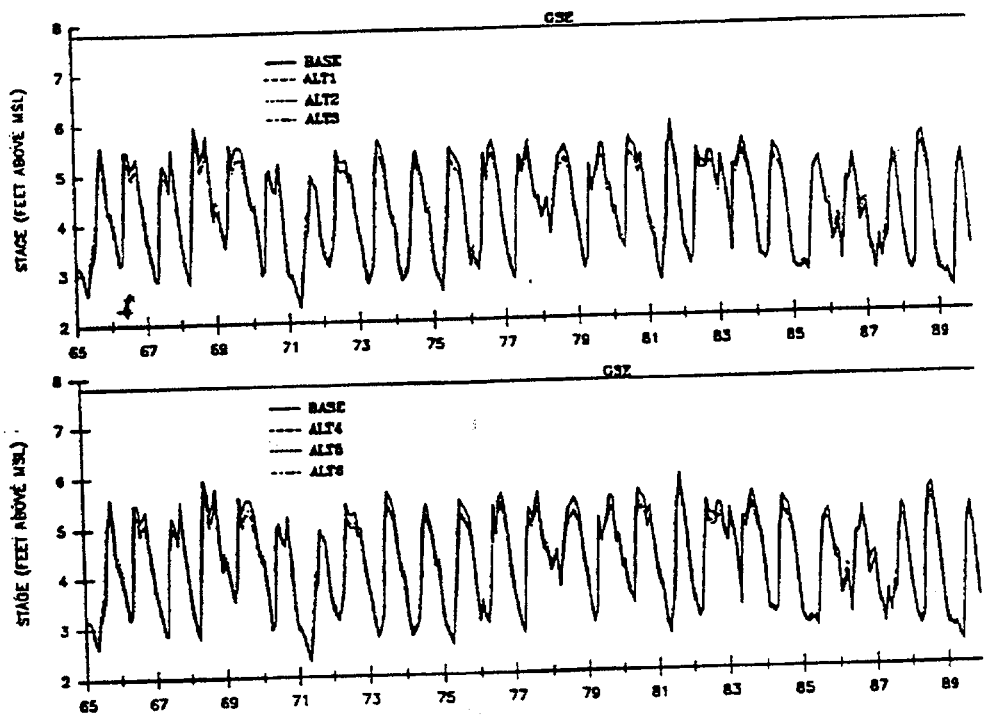


Figure 31: Stages at G-789

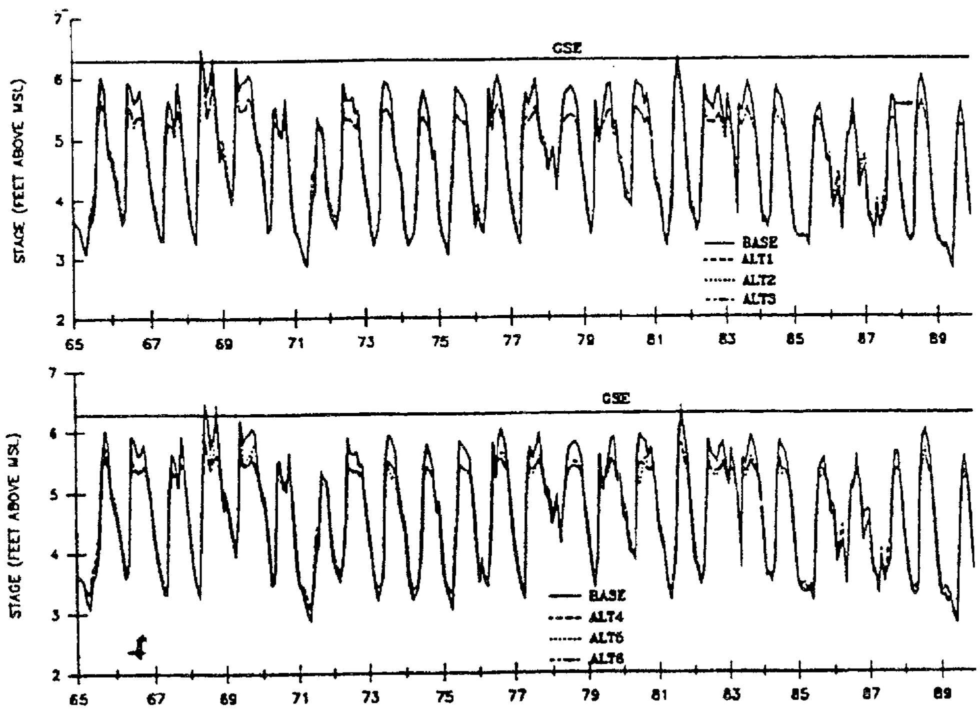


Figure 32: Stages at RUTZKE

Alternatives 2 through 6 all slightly lowered wet season water levels compared to the base condition, presumably in response to the increased outflow capacity in the L- 31N canal. At the Frog Pond gage, Alternatives 4 and 6 tend to lower wet season water levels, while Alternatives 2, 3, and 5 significantly raised wet season water levels, and Alternative 1 showed essentially no major changes. In general, the agricultural areas of the Rocky Glades and the Frog Pond had water levels rising into the root zone (less than 1.50 feet below the ground surface) approximately 50 percent of the time under all of the model runs. At gage G-596 in the East Everglades, flooding within the root zone occurred approximately 40 percent of the time, even with the added protection of the proposed seepage control system associated with the Modified Water Deliveries GDM. This shows that all of the developed areas west of the Eastern Protective Levee System are at a high risk of flooding due to their proximity to the Everglades.

8.3 Water Depth/Hydroperiod Impacts in Upper Taylor Slough and the Rocky Glades.

Fig. 33 shows the expected water level conditions at the R-3110 gage in the upper Taylor Slough basin, under the base and alternative plans. The hydrologic conditions at this site are typical of the conditions in the Rocky Glades headwaters and the upper portion of the Taylor Slough watershed. The model results indicate that all of the marshes in this sub-region experience surface water flooding for 3 to 9 months each year under the base condition and the proposed alternatives. The results vary quite a bit in this area in response to the differences in the location of structure inflows, but all of the alternatives produced an increase in wet season water levels. In the Rocky Glades wetlands, Alternatives 4 and 6 have the most significant impact on wet season water levels, and hydroperiods showed a slight increase of approximately 10 percent (1 month). Alternatives 1, 3, and 5 have the greatest impact on wet season water levels in the marshes adjacent to the L-31W canal. At gage R3110, hydroperiods increased by up to 15 percent (under Alternatives 3 and 5). Wet season water levels also showed a small increase at the TSB gage, but hydroperiods were unaffected, or decreased slightly.

8.4 Water Depth/Hydroperiod Impacts in Lower Taylor Slough.

Fig. 34 shows the expected water level conditions at the P-37 gage in the lower Taylor Slough basin, under the base and alternative plans. The hydrologic conditions at this site are typical of the conditions in the watershed south of the L-31W canal system. The model results indicate that all of the marshes in this sub- region experience surface water flooding for 6 to 10 months each year under the base condition and the proposed alternatives. Wet season water levels at the P-37 and the CPOND gages showed almost no change under any of the alternatives. The R-127 gage showed a slight reduction in wet season water levels under Alternatives 3 and 5, presumably in response to the reduced conveyance caused by the removal of the lower portion of the L-31W canal. At all 3 grid cells the hydroperiods were essentially unaffected by any of the proposed structural changes.

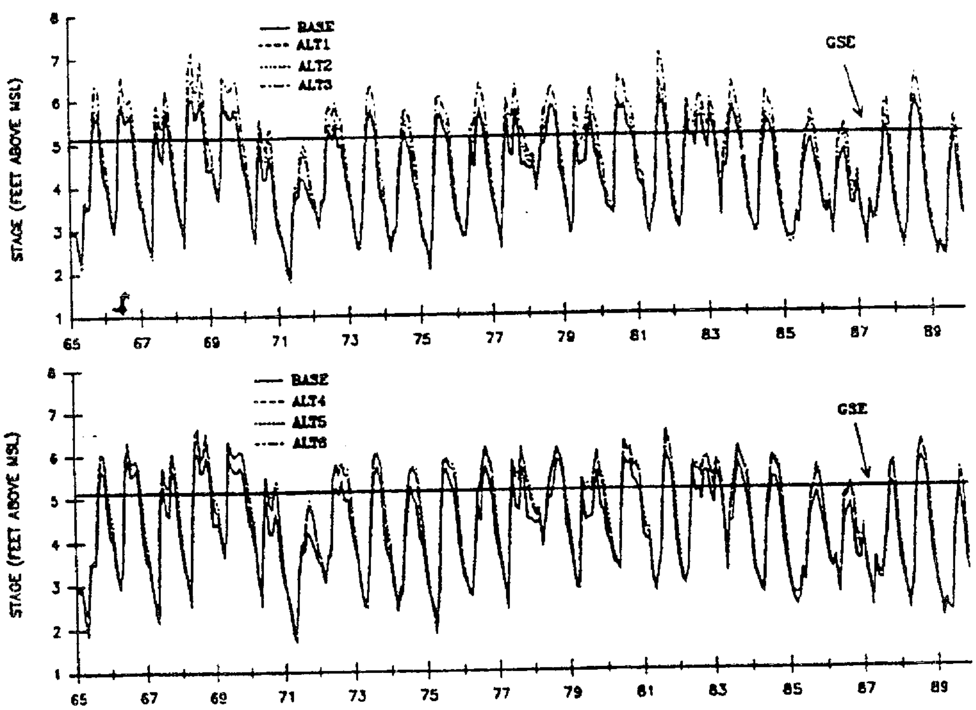


Figure 33: Stages at R-3110

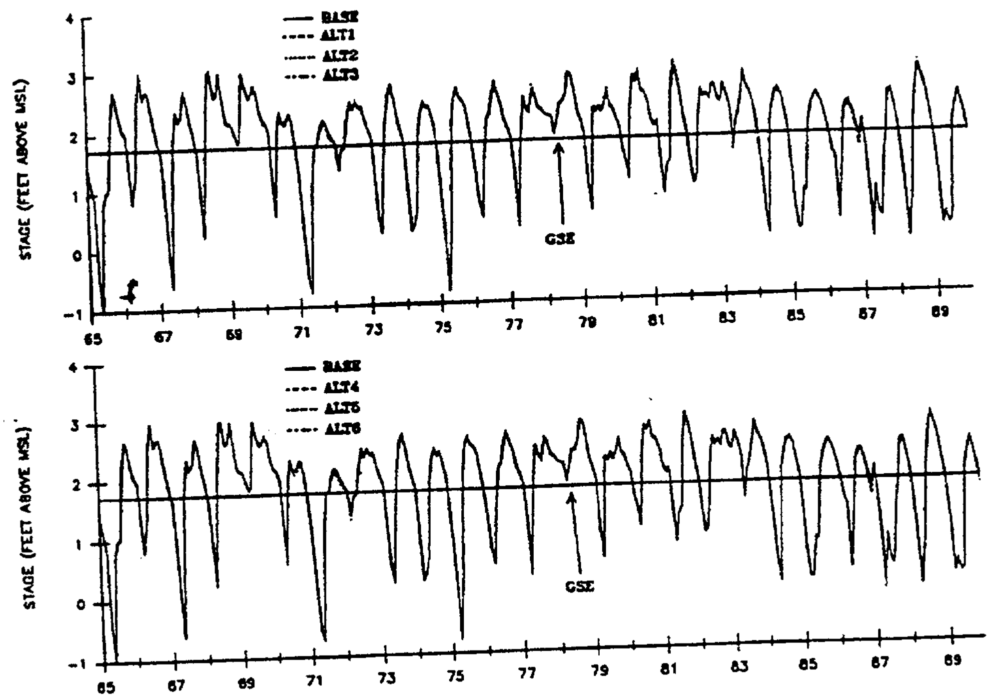


Figure 34: Stages at P-37

8.5 Water Depth/Hydroperiod Impacts in the Lower C-111 Basin.

Fig. 35 shows the expected water level conditions at the G-3354 gage in the lower C-111 basin, under the base and alternative plans. The hydrologic conditions at this site are typical of the conditions in the impounded area just north of the C-111 canal system. At the G-3354 gage, Alternatives 1, 2, and 6 slightly lower wet season water levels, while Alternatives 3, 4, and 5 significantly lower wet season water levels. This is presumably as a result of the removal of the northern levee, which is used as fill to completely or partially backfill the lower C-111 canal. At gages EP-SW/GW and G-1251 water levels and hydroperiods show no significant impacts during the wet season under any of the proposed alternatives. During the dry season, water levels tend to be lower under all the alternatives that backfill the C-111 canal. Examination of all of the gages in this area shows that the marshes north of the C-111 canal have substantially higher wet season water levels, and maintain much longer hydroperiods then the wetlands south and west of the C-111 canal. This is a result of the levee system along the northern and eastern side of the lower C-111 canal. This levee system holds back wet season runoff which would otherwise provide sheetflow to the downstream marshes and Florida Bay.

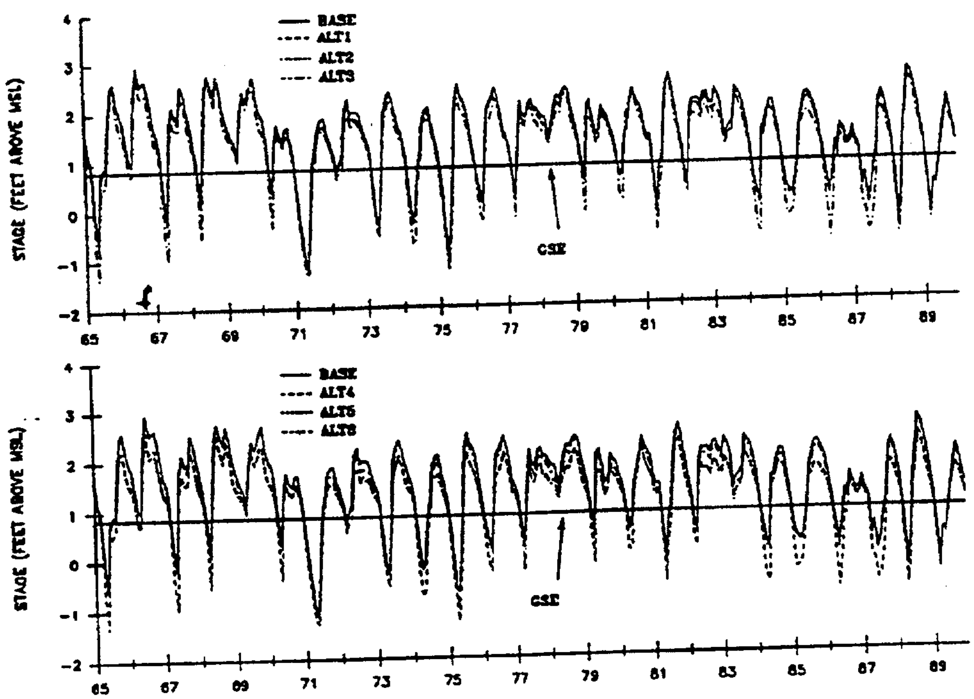


Figure 35: Stages at G-3354

9 Spatial Surface Water Depth Comparisons

One of the many outputs of the model are end-of-month surface water depths for each grid cell. These values were post-processed and brought into GRASS, a public domain GIS package. GRASS has excellent spatial analysis features, which were used to compute the differences in water depths between the base condition and the alternatives. ARC/INFO© and GRASS overlays were used to make water depth and hydroperiod maps, which were helpful in making spatial comparisons. Surface water depths for each cell were placed into specified categories and both a tabulation and map were produced. The spatial analyses consisted principally of surface subtractions between base and each alternative. These subtractions compute the difference in water depth between the two model outputs and are carried out on each corresponding grid cell. All of the runs were computed so that the base condition was subtracted from each of the alternatives. Thus, a negative number indicates reduced surface water depths (increased drainage) in that cell, while a positive value indicates increased surface water depths under the alternative.

The first set of data obtained from the model runs and post-processed are the total number of cells, or area in mi^2, which are inundated with depths greater than 0.01 ft. These depths consist of all the classes from category 2 and up (see Table 3). The water depth values at the end of each particular month were averaged over the entire 25-year period and the total number of inundated cells or mi^2 (each cell is one mile square) are tabulated and presented in Appendix B. Using this approach alone makes it difficult to determine the differences between the base and alternative plans. The average monthly values and the average annual values indicate that little or no increase in surface water occurs under any of the alternatives.

9.1 Average Changes in Surface Water Depth for the 25-Year Period

To illustrate the spatial patterns of increases and decreases of surface water depths, surface subtractions were computed and tabulated in different categories. These categories are presented in Table 4, the "difference" indicates the difference in water depth between base and alternative. Only categories with small ranges in values were needed, since large changes in surface water depths did not occur anywhere in any of the model runs, indicating the lack of significant water depth decreases or increases in the wetlands.

The results of these surface substractions are shown in Table 5. The top

Category	Depth Range	Category	Depth Range
1	no surface water	6	1.0 < depth ≤ 1.5 ft.
2	0.01 < depth ≤ 0.25 ft.	7	1.5 < depth ≤ 2.0 ft.
3	0.25 < depth ≤ 0.50 ft.	8	2.0 < depth ≤ 2.5 ft.
4	0.50 < depth ≤ 0.75 ft.	9	depth > 2.5 ft.
5	0.75 < depth ≤ 1.00 ft.		

Table 3: Surface Water Depth Classifications

Subtraction Category	Difference in Water Depth	Depth Category	Difference in Water Depth
1	difference < -0.10 ft.	5	0.10 > difference ≥ 0.20 ft.
2	-0.10 ≤ difference < 0	6	0.20 > difference ≥ 0.30 ft.
3	no difference	7	difference > 0.30 ft.
4	0.10 > difference ≥ 0.10		

Table 4: Classifications for the Changes in Surface Water Depth Analysis

section of the table contains the increases in area which have additional surface water inundation under each proposed alternative. Conversely, the bottom section tabulates the areas which have less surface water under the proposed alternative than they had under the base condition. The latter section of the table contains the area during each month which have lower water depth under the alternative than under base conditions. A large section of this increased drainage is located in the Eastern Panhandle area, where under several of the alternatives, the deep water pools north of C-111 will be eliminated.

In order to realize some benefit to the Park, the surface water depth increases for the preferred alternative should be significant. Category 7 contains the areas which show increases of greater than 0.03 ft. of surface water depth. This category of very modest increase in water depth is tabulated in Table 6. No benefits during the dry season are derived from any of the alternatives, this is indicated as the zero in the months from January through April. Small increases, less than 10 mi^2, are realized in Alternatives 3 through 6 during the wet season months. The increase in Alternative 3 during the wet season is due to the additional area inundated in the Frog Pond (the Surge Pool and STA) and the increase in deliveries to the Eastern Panhandle. This additional inundation in the lower C-111 basin is principally due to the large seepage losses from the Surge Pool being picked up in the canal and passed into C-500E by

Water depth increases with the alternative Categories > 3. Positive Differences.						
Month	A1-Bse	A2-Bse	A3-Bse	A4-Bse	A5-Bse	A6-Bse
January	165	141	257	453	188	455
February	115	109	190	404	171	399
March	69	58	121	281	106	275
April	53	52	100	209	79	186
May	98	125	134	251	123	225
June	192	254	232	389	228	359
July	249	318	339	509	310	472
August	271	310	365	586	330	535
September	321	340	398	650	382	586
October	323	327	404	684	384	630
November	269	279	367	632	304	587
December	191	186	275	521	212	495
Average	193	208	265	464	234	433

Water depth decreases with the alternative Categories < 3. Negative Differences Number of Cells or Area in mi^2						
Month	A1-Bse	A2-Bse	A3-Bse	A4-Bse	A5-Bse	A6-Bse
January	26	33	24	50	88	28
February	29	36	33	50	90	33
March	18	23	27	30	60	19
April	25	26	62	64	66	35
May	37	36	107	94	98	65
June	54	55	146	131	142	139
July	39	46	122	102	127	118
August	42	57	128	58	136	81
September	56	88	137	69	143	87
October	38	78	128	61	137	69
November	23	47	47	31	117	34
December	24	31	24	34	95	27
Average	34	46	82	65	108	61

Table 5: Average Number of Cells which Show a Change in Surface Water Inundation.

Category 7. Differences greater than 0.03 ft.						
Number of Cells or Area in mi^2						
Month	A1–Bse	A2–Bse	A3–Bse	A4–Bse	A5–Bse	A6–Bse
January	0	0	0	0	0	0
February	0	0	0	0	0	0
March	0	0	0	0	0	0
April	0	0	0	0	0	0
May	0	0	1	0	1	0
June	1	0	14	8	8	7
July	0	0	20	9	12	9
August	0	3	25	16	14	15
September	2	6	29	26	18	22
October	0	2	26	16	20	16
November	0	0	5	2	6	2
December	0	0	1	0	0	0
Average	0	1	10	6	7	6

Table 6: Average Number of Grid Cells which Show a Change in Surface Water Depth greater than 0.03 feet.

the 500 cfs pump. Increases in wet season water levels in Alternative 5 occur west of S-174, due to the addition of the large pump. Spacing of pumps west of the Eastern Protective Levee System at five location produces water level increases which are located adjacent to the discharges, starting just south of the 8.5 m^2 area.

9.2 Average Changes in Surface Water Depth for Selected Water Years

The end-of-month surface water depths for the selected water years of 1976–1977, 1973–1974 and 1968–1969 were also post-processed and tabulated. The total area which is inundated with surface water depths greater than 0.01 ft. at the end of every month during the selected year and the annual averages are tabulated in the tables in Appendix B. The information was used to make comparisons between the Base and alternative conditions. By subtracting the water depths between the alternative and base, similar to the procedure described earlier, the difference in water depths were obtained. A positive difference (diff > 0) indicates a gain in water depth with the alternative. The results were again classed in the specific categories (see Table 4)

Category	A1–Bse	A2–Bse	A3–Bse	A4–Bse	A5–Bse	A6–Bse
	Average Water Year		1976-1977			
diff ≤ -0.1	0	0	2	7	8	1
$-0.1 <$ diff < 0	30	57	49	35	71	41
No change	1297	1263	1203	938	1203	965
$0 <$ diff ≤ 0.1	225	220	259	524	239	503
$0.1 <$ diff ≤ 0.2	5	16	23	36	18	32
$0.2 <$diff ≤ 0.3	0	1	11	13	12	12
diff> 0.3	0	0	10	4	6	3
	Dry Water Year		1973-1974			
diff ≤ -0.1	0	1	2	6	9	0
$-0.1 <$ diff< 0	32	45	106	39	108	41
No change	1347	1319	1255	1084	1252	1099
$0 <$diff ≤ 0.1	178	189	172	409	167	400
$0.1 <$ diff ≤ 0.2	0	3	14	17	16	16
$0.2 <$diff≤ 0.3	0	0	5	2	2	1
diff > 0.3	0	0	3	0	3	0
	Wet Water Year		1968-1969			
diff ≤ -0.1	4	4	8	12	13	6
$-0.1 <$ diff < 0	40	62	64	67	89	78
No change	1129	1059	921	762	951	805
$0 <$diff ≤ 0.1	373	405	469	615	447	580
$0.1 <$ diff ≤ 0.2	4	22	59	70	38	61
$0.2 <$ diff≤ 0.3	3	2	13	27	11	24
diff> 0.3	4	3	23	4	8	3

Table 7: Surface Water Depth Differences for Selected Water Years

and are summarized in Table 7 for the water years defined earlier.

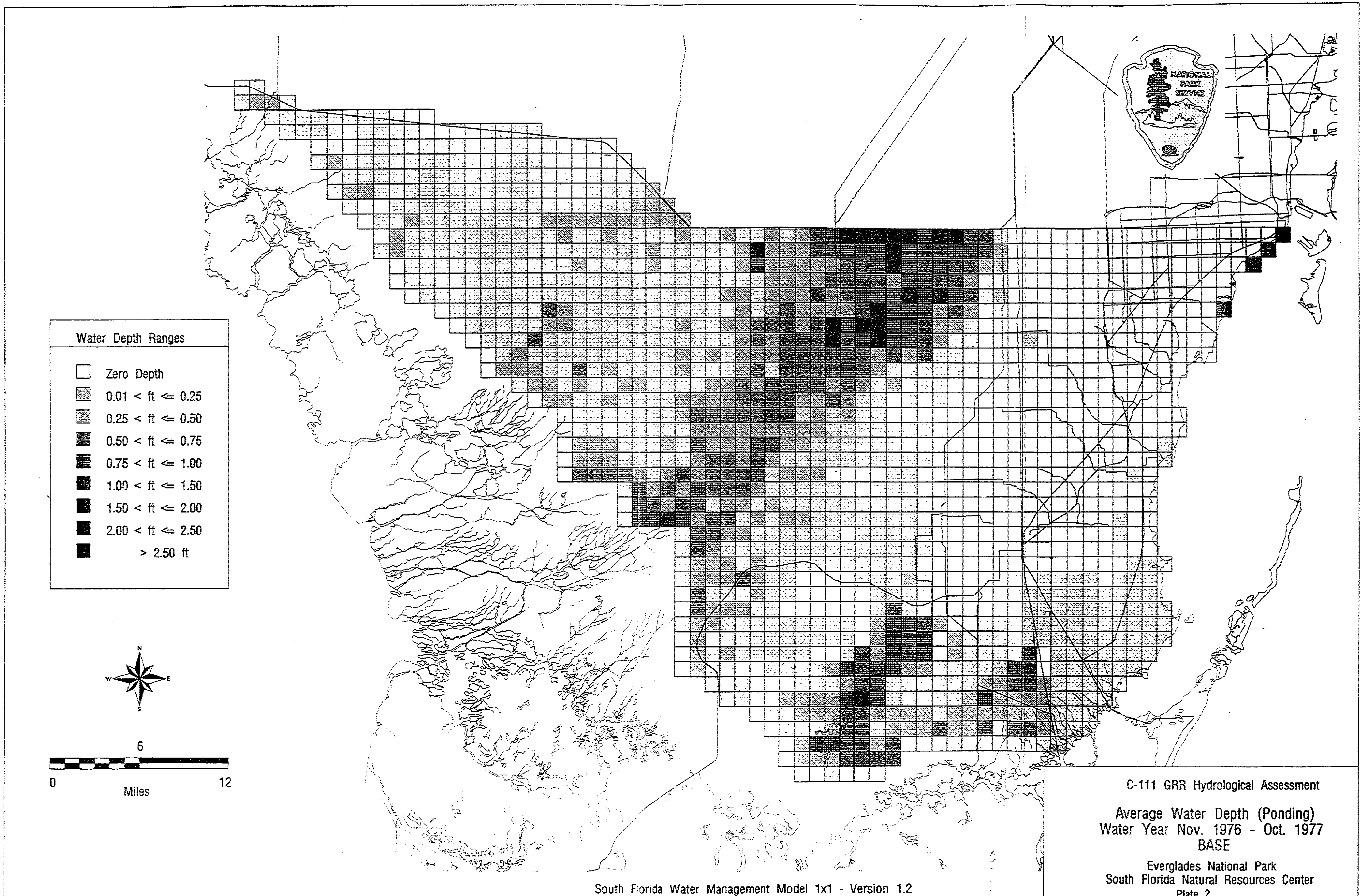
In addition to the tabulation the spatial distribution of the increases and decreases in water depths can be visualized by inspecting the surface subtraction maps between the base and each of the alternatives. The same categories were used as presented in Table 7. The water year 1976–1977 was selected for its "average" condition. The end-of-month water depth values were used to compute an annual average. Color plate 2 (Fig. 36) presents the average water depth for the water year 1976–1977 for the base condition. Color plates 3 thru 8 (Figs. 37, 38, 39, 40, 41, and 42) show the spatial water depth differences between each alternative and base as tabulated in Table 7.

Using the table and the plates, the spatial distributions (hydropatterns) of the water depths in base and the changes that occur in the alternatives can be described. The Base condition (Fig. 36, Plate 2) shows the pattern of surface water for different depth categories. The Shark Slough, Taylor Slough and the flow section in the Eastern Panhandle can be readily distinguished. The ponding in the State lands north of the cutouts in lower C-111 can also be discerned. During these average conditions no surface water greater than two feet occurs, however during the wet season some deep water pools are present. The Rocky Glades and northern Taylor Slough have very little standing water which lasts throughout the year, the average conditions are less than 0.25 ft. This area extends as far south as the S-332 pump and persistent standing water does not occur until south of the Park road.

Similar conditions prevail in Alternatives 1, 2, 3 and 5. Most of the surface water is located near the discharge point in Taylor Slough. The Rocky Glades area receives negligible benefit from these alternatives. Alternatives 4 and 6 show a wider distribution of surface water extending well into the Rocky Glades. Most of the increases in surface water are small (less than 0.2 ft.) but at least the area of persistent inundation has almost doubled (Table 7), as compared to the other alternatives. If seepage can be controlled and canal levels are brought back to proper operational levels, the concepts contained in these alternatives may provide some hydrological benefit to the wetlands.

The additional drainage illustrated by the yellow colorations in the figure and tabulated as negative categories in Table 7 occur in the Rocky Glades in Alternatives 2, 3 and 5. This is a result of the continued practice of draining NESS and passing the excess water via the canals to the large pumps next to Taylor Slough. All of the alternatives show a decrease in surface water in the Eastern Panhandle. Most of this decrease is due to the reduction of discharge through S-176 to the south, and the removal or degradation of lower C-111 in Alternatives 3, 4 and 5, without compensating with higher operational canal levels in C-500E and C-111.

Operational changes are needed in all of the alternatives. Proper canal stages may show some benefit in the wetlands of the C-111 basin, but changes were not tested as part of this report.

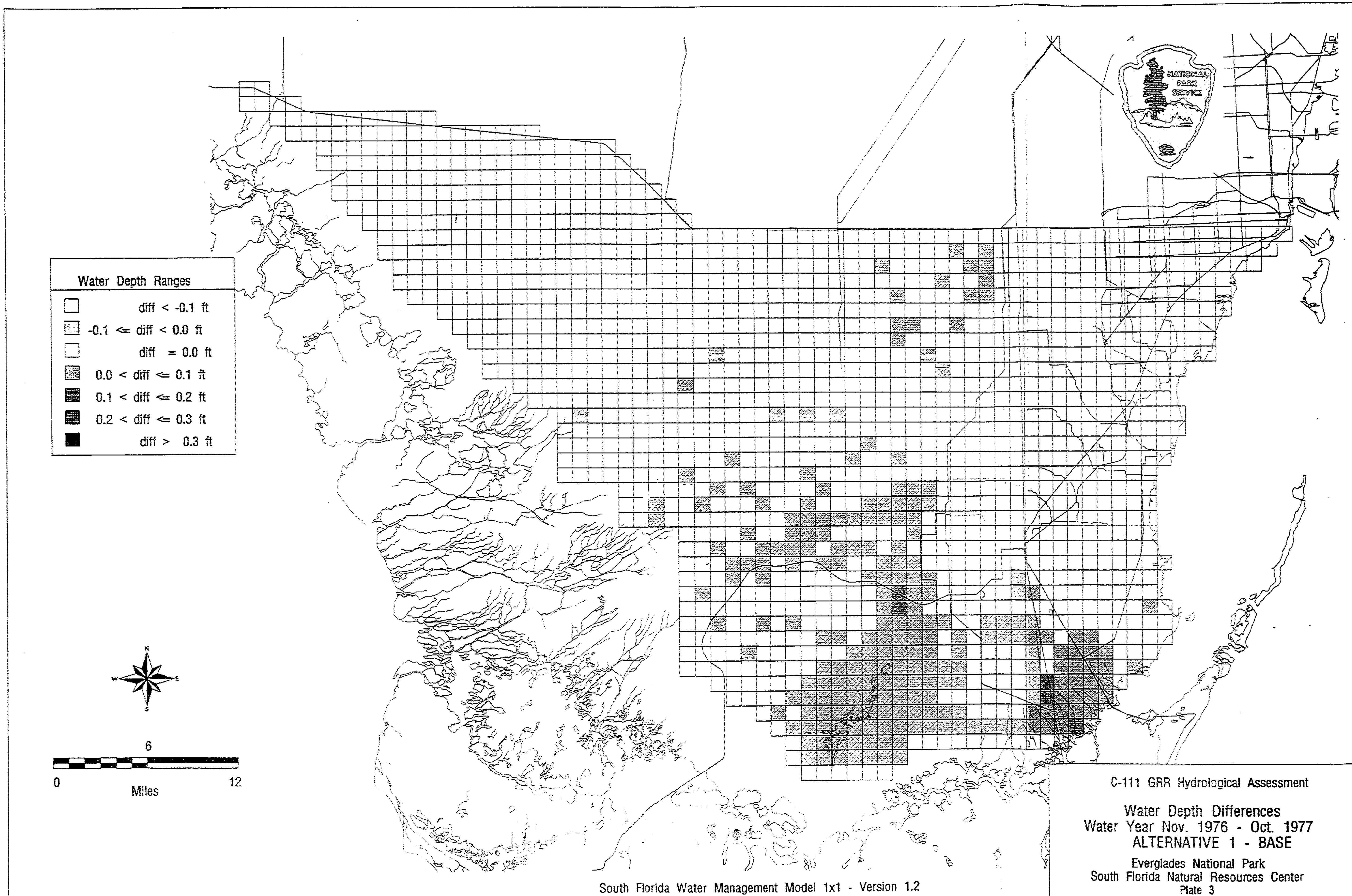


C-111 GRR Hydrological Assessment

Average Water Depth (Ponding)
Water Year Nov. 1976 - Oct. 1977
BASE

Everglades National Park
South Florida Natural Resources Center
Plate 2

GRASS-ARC/INFO base_7677 12/06/1993

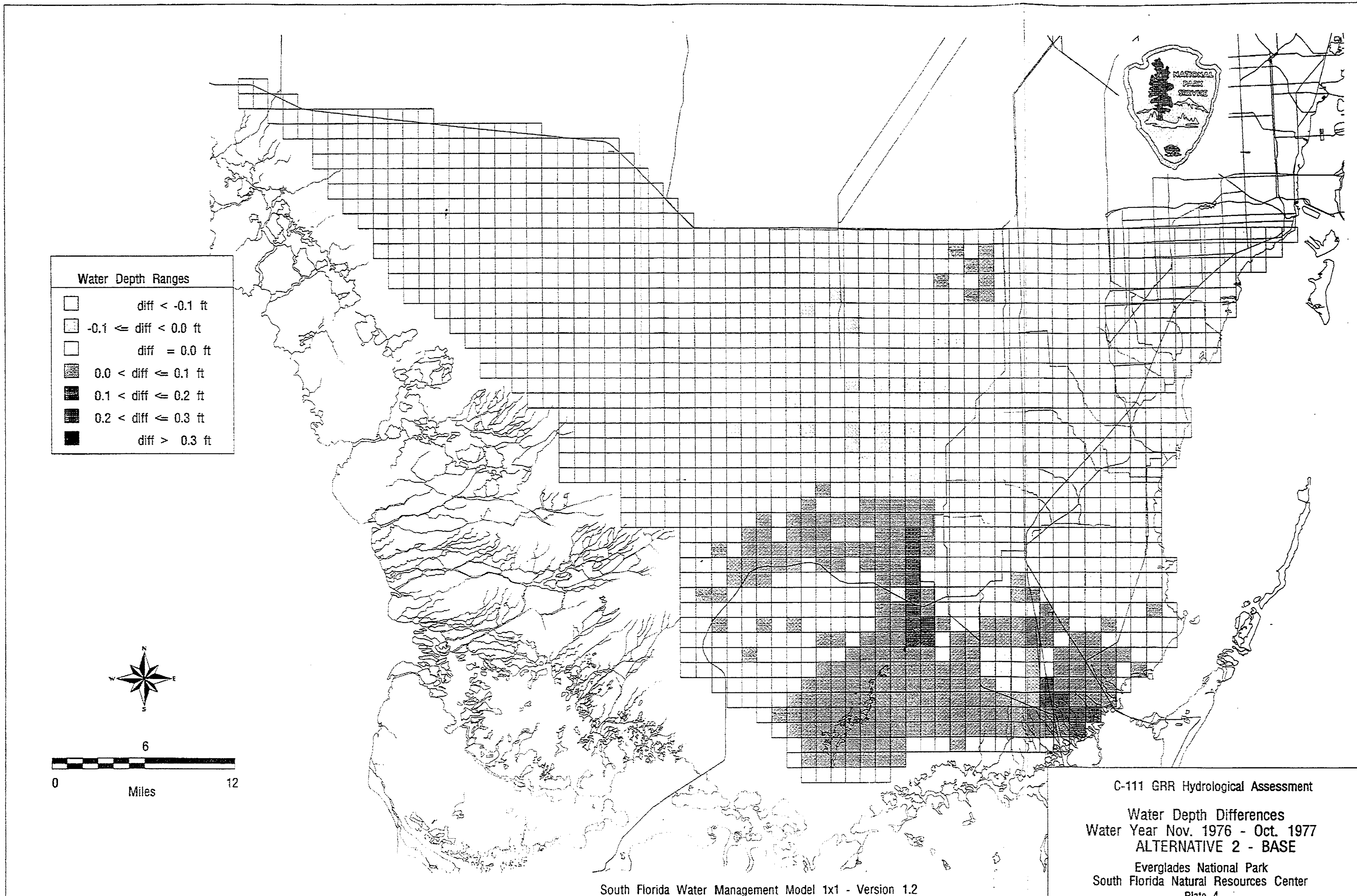


C-111 GRR Hydrological Assessment

Water Depth Differences
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 1 - BASE

Everglades National Park
South Florida Natural Resources Center
Plate 3

GRASS-ARC/INFO psub_alt17677 12/04/1993

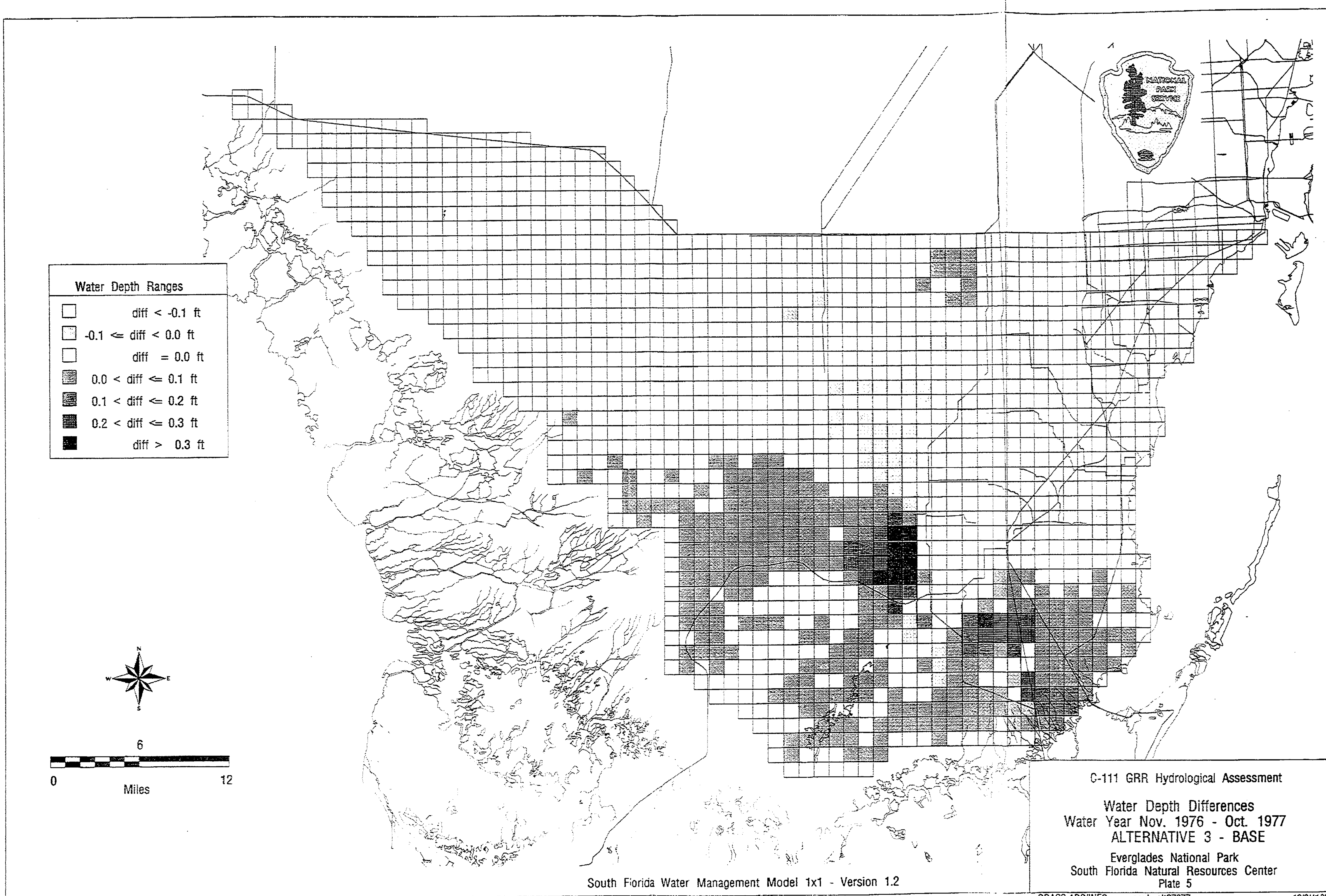


C-111 GRR Hydrological Assessment

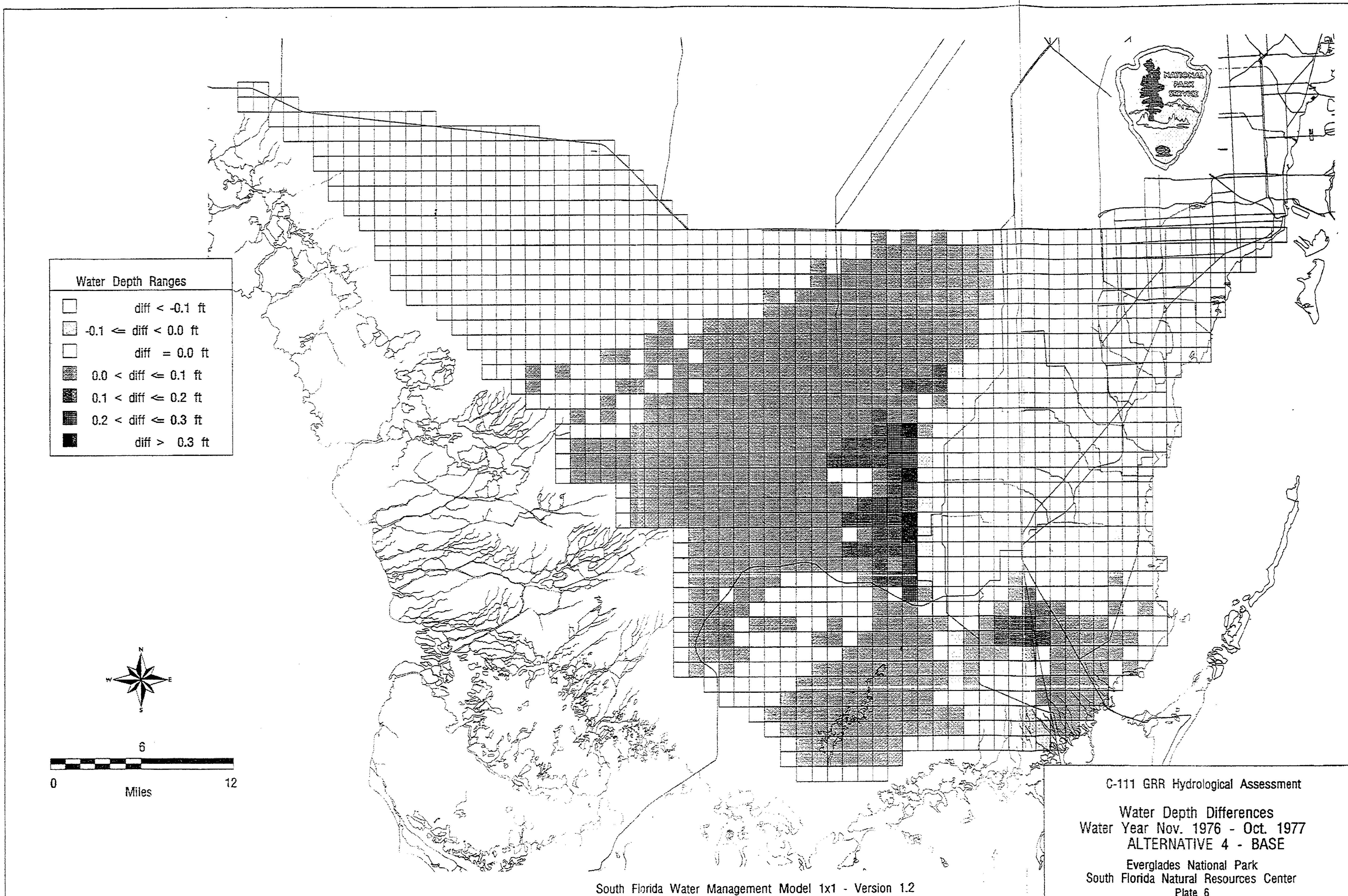
Water Depth Differences
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 2 - BASE

Everglades National Park
South Florida Natural Resources Center
Plate 4

GRASS-ARC/INFO psub_alt27677 12/04/1993



Water Depth Ranges
diff < -0.1 ft
-0.1 <= diff < 0.0 ft
diff = 0.0 ft
0.0 < diff <= 0.1 ft
0.1 < diff <= 0.2 ft
0.2 < diff <= 0.3 ft
diff > 0.3 ft
NATIONAL PARK SERVICE
N
W
E
S
6
0
12
Miles
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Water Depth Differences
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 3 - BASE
Everglades National Park
South Florida Natural Resources Center
Plate 5
GRASS-ARC/INFO
psub_alt37677
12/04/1993

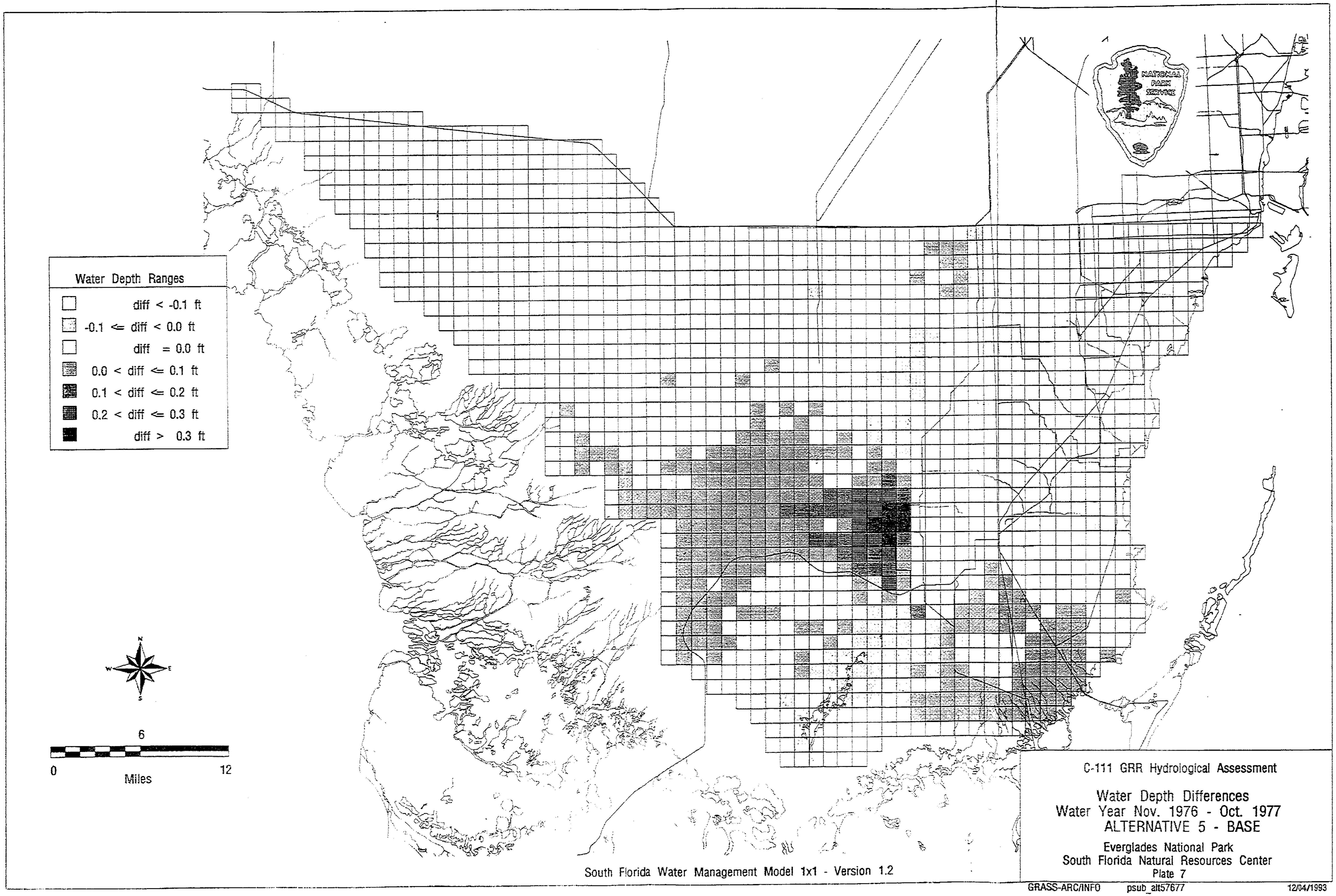


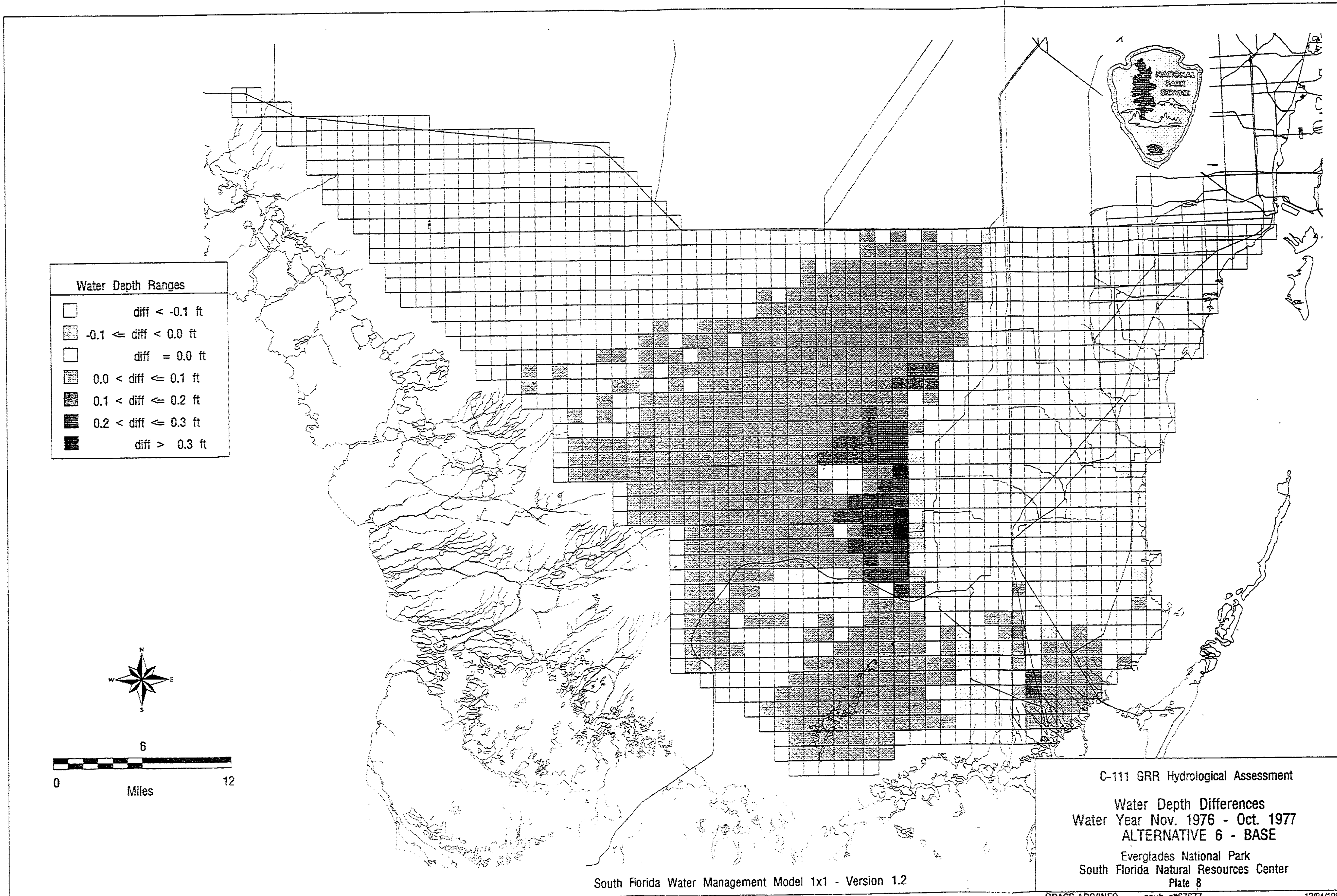
C-111 GRR Hydrological Assessment

Water Depth Differences
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 4 - BASE

Everglades National Park
South Florida Natural Resources Center
Plate 6

GRASS-ARC/INFO psub alt47677 12/04/1993


Water Depth Ranges
diff < -0.1 ft
-0.1 <= diff < 0.0 ft
diff = 0.0 ft
0.0 < diff <= 0.1 ft
0.1 < diff <= 0.2 ft
0.2 < diff <= 0.3 ft
diff > 0.3 ft
NATIONAL PARK SERVICE
N
W
E
S
6
0
Miles
12
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Water Depth Differences
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 5 - BASE
Everglades National Park
South Florida Natural Resources Center
Plate 7
GRASS-ARC/INFO
psub_alt57677
12/04/1993



C-111 GRR Hydrological Assessment

Water Depth Differences
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 6 - BASE

Everglades National Park
South Florida Natural Resources Center
Plate 8

GRASS-ARC/INFO psub_alt67677 12/04/1993

Time Ranges	
transitional	< 3 months
short	3 – 5 months
intermediate	6 – 10 months
long	11 – 12 months

Table 8: Hydroperiod Classifications

10 Spatial Hydroperiod Comparisons

The length of time that a grid cell has surface water during a particular water year is the hydroperiod of that cell. Daily surface water depths (ponding) for each grid cell were obtained for each of the alternatives and the Base condition. Annual (water year) hydroperiods for each grid cell were computed from this information by adding the number of days when surface water depth exceeded 0.01 ft. To reduce the amount of information the hydroperiods were subdivided into four time categories (Table 8). The transitional category, for example, is the class of cells which is not considered a fully functional wetland in the Everglades, but is viewed as being overdrained and no longer capable of maintaining native wetland vegetation. Many of these areas have experienced severe fire damage, suffer from exotic woody plant invasion and have low periphyton production. The hydroperiod information for the Base condition and each of the alternatives for a typical average, dry and wet year is presented in Table 9. This table lists the total model area in mi^2 which remains inundated for a particular time period.

For example, under the Base condition, during a typical average year 176 mi^2 of the model domain was inundated for less than 3 months per water year, while the area covered under Alternative 6 saw a reduction of 23 mi^2 in the transitional category.

10.1 Changes in Hydroperiods for Selected Water Years.

Surface subtractions on the hydroperiods were carried out in GRASS between the base run and each alternative. The results are summarized in Table 10 for the water years under consideration. This table describes the difference between the hydroperiods (Δp) for three depth ranges. The positive categories list the additional area in mi^2 which has that range of additional hydroperiod, while the two negative categories are the areas with reduced inundation.

Condition	none 0	transitional < 3 mnths	short 3-5 mnths	intermediate 6-10 mnths	long 11-12 mnths
	Average Year 1976-1977		Depth > 0.01		
Base	339	$\boxed{176}$	284	515	243
Alternative 1	341	165	284	520	247
Alternative 2	345	156	279	531	246
Alternative 3	338	159	260	554	246
Alternative 4	345	156	245	567	244
Alternative 5	339	160	257	554	247
Alternative 6	348	$\boxed{153}$	247	559	250
	Dry Year 1973-1974		Depth > 0.01		
Base	387	137	257	738	28
Alternative 1	396	133	253	747	28
Alternative 2	395	123	269	743	27
Alternative 3	392	117	267	755	26
Alternative 4	396	109	264	760	28
Alternative 5	397	113	267	753	27
Alternative 6	401	108	260	759	29
	Wet Year 1968-1969		Depth > 0.01		
Base	287	128	81	411	650
Alternative 1	287	124	76	414	656
Alternative 2	290	123	71	417	656
Alternative 3	287	120	65	424	661
Alternative 4	288	125	70	420	654
Alternative 5	288	121	69	432	647
Alternative 6	290	122	74	409	662

Table 9: Total Model Area (mi^2) Inundated for each Hydroperiod Category.

Category	A1-Bse	A2-Bse	A3-Bse	A4-Bse	A5-Bse	A6-Bse
	Average Year 1976-77		Depth > 0.01			
$\Delta p \leq -30$	0	4	3	8	3	4
$-30 < \Delta p < 0$	70	128	111	94	121	88
$\Delta p = 0$	1098	1096	990	800	966	821
$0 < \Delta p \leq 15$	353	259	326	524	375	523
$15 < \Delta p \leq 30$	27	36	52	55	31	55
$30 < \Delta p \leq 45$	6	14	26	22	18	19
$45 < \Delta p \leq 60$	0	5	17	14	10	11
$\Delta p > 60$	3	15	32	40	33	36
	Dry Year 1973-74		Depth > 0.01			
$\Delta p \leq -30$	0	1	9	15	4	
$-30 < \Delta p < 0$	51	130	134	87	178	77
$\Delta p = 0$	1180	1172	1061	862	1069	905
$0 < \Delta p \leq 15$	315	211	269	498	236	498
$15 < \Delta p \leq 30$	6	19	37	44	30	36
$30 < \Delta p \leq 45$	3	11	11	12	11	9
$45 < \Delta p \leq 60$	0	2	11	15	7	11
$\Delta p > 60$	2	11	25	24	22	21
	Wet Year 1968-1969		Depth > 0.01			
$\Delta p \leq -30$	0	4	6	15	7	9
$-30 < \Delta p < 0$	86	130	111	106	153	101
$\Delta p = 0$	1124	1099	1059	1021	1055	1045
$0 < \Delta p \leq 15$	328	291	244	301	246	314
$15 < \Delta p \leq 30$	16	22	68	73	46	60
$30 < \Delta p \leq 45$	1	6	35	20	19	15
$45 < \Delta p \leq 60$	2	1	16	13	20	8
$\Delta p > 60$	0	4	18	8	11	5

Table 10: Difference between Hydroperiods

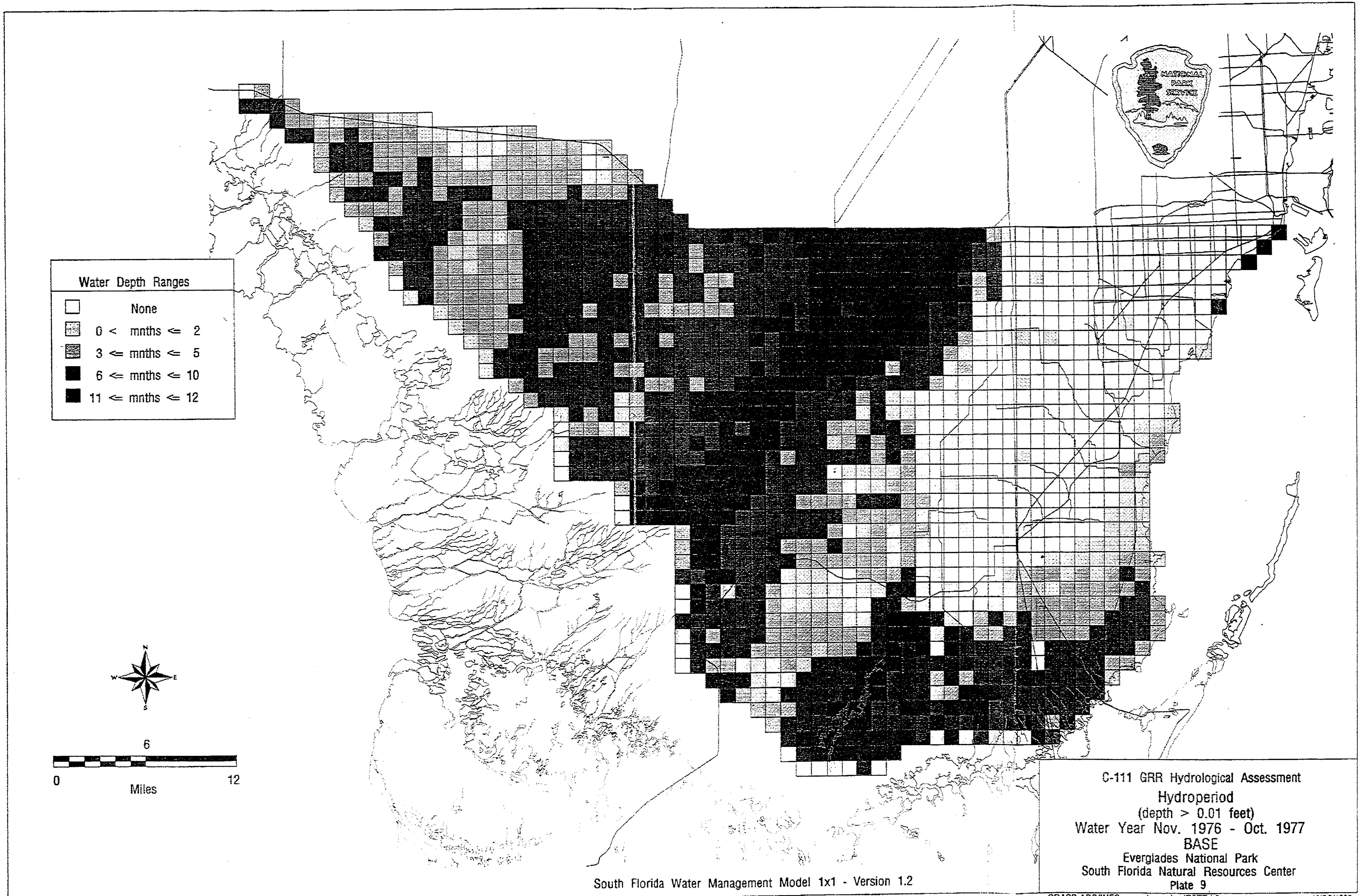
The average water year of 1976–1977 was used to illustrate the spatial distribution of the different hydroperiod categories. The base condition tabulated in Table 9 is shown in Color plate 9 (Fig. 43) using the same categories described earlier. Color plates 10 thru 15 (Figs. 44, 45, 46, 47, 48, and 49) show the spatial hydroperiod differences tabulated in Table 10.

The hydroperiod color plate illustrating the Base condition (Fig. 43, Plate 9) shows the long hydroperiods in the central portion of the sloughs. The long hydroperiod in the original main flowway of Shark Slough, now referred to as Northeast Shark Slough, is well illustrated. The lack of significant periods of inundation along the eastern edge of Shark Slough and into the headwaters of Taylor Slough was caused by the drainage operations of the C&SF Project. Much of the historical peripheral marsh between the Coastal Ridge and the main Sloughs has disappeared. Current attempts to re-inundate NESS, the Rocky Glades and Taylor Slough are an attempt to regain a portion of these marshes. With all of the alternatives, moderate increases in hydroperiods are observed near the main discharge points (the new pumps). Although increases near these points occur, all the alternatives decrease the length of the hydroperiods in the historical eastern Rocky Glades and lower C-111 area.

In excess of 15% of the area show a reduction in surface water if any of the alternatives is implemented. During the 1976–1977 water year Alternative 2 increased the drainage of the Rocky Glades and central Taylor Slough to such an extent that 40% of the increase in hydroperiod gained in the headwaters of Taylor Slough, by the large pump, is lost (see Table 10). Moderate gains are made with Alternatives 4 and 6, the area which had a longer hydroperiod, up to 2 weeks, increased by 67%. The spatial differences between each of the alternatives and Base indicate that the hydroperiods in the Eastern Panhandle, especially in the impounded marshes east of S-18C are substantially shortened. Under current water management practices, these areas have long hydroperiods. Lowering of the canal levels and the partial or total removal of the levees with Alternatives 3, 4 and 5 show reductions in hydroperiods of up to one month.

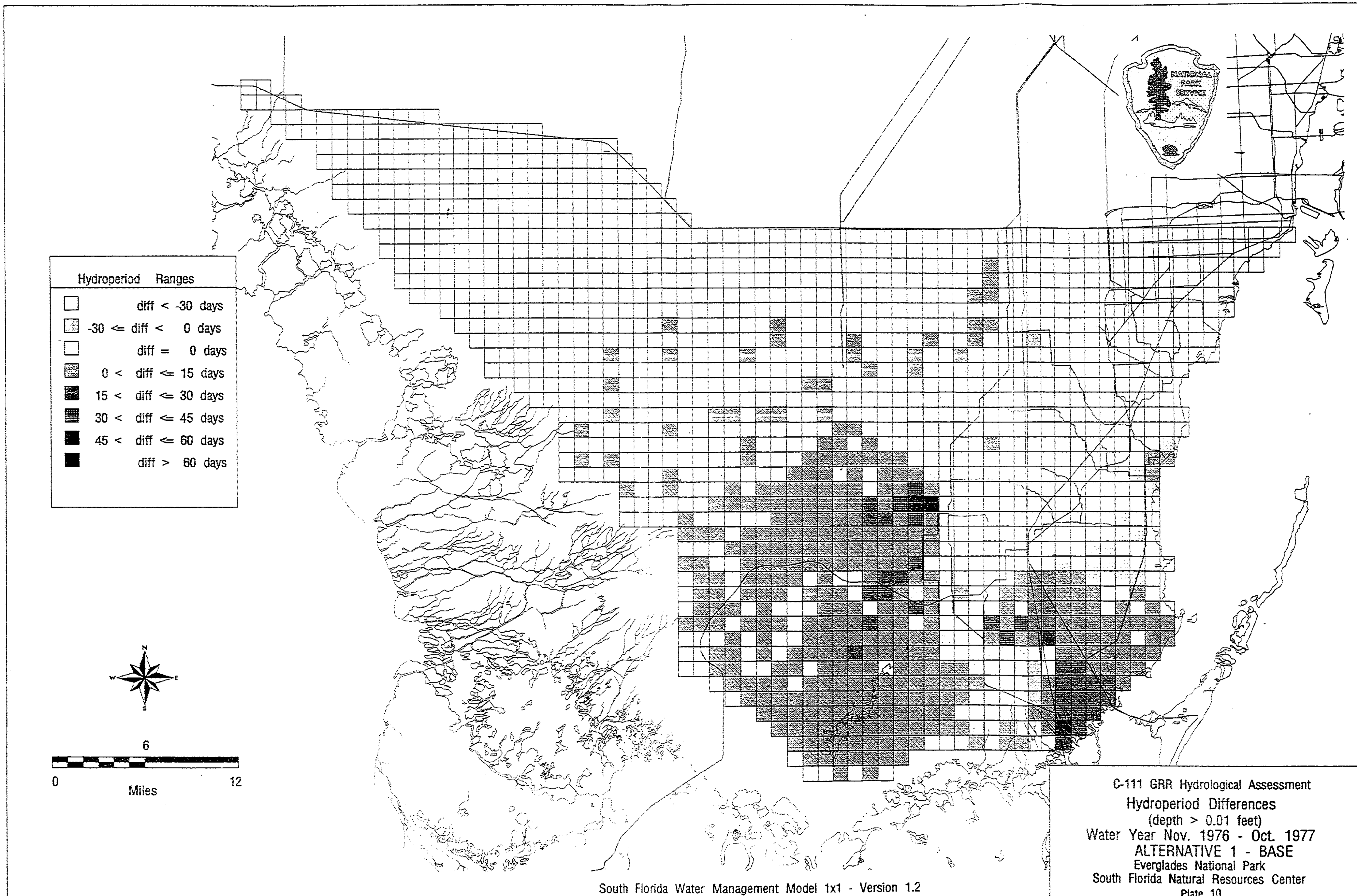
Inspection of the color plates clearly shows the operational practices of the C&SF Project. With large pumps located at single points, as all but two of the alternatives do, increases the ability to provide additional flood protection, but also causes vast areas in the wetlands to experience additional drainage. The small gains made in hydroperiods at selected points in the marshes are offset by the losses in the historical eastern Rocky Glades and lower C-111 area. Even with the spacing of pumps and the short increase in retention of flood waters in Alternative 3, no significant spatial gains in hydroperiods are made.

The need to incorporate new operational criteria to maintain stages, thereby increasing hydroperiods, and the lack of attempts to control the seepage losses into L-31N, L-31W and C-111 are two of the most important items why the alternatives fail to provide even moderate gains in the spatial distribution of hydroperiods.

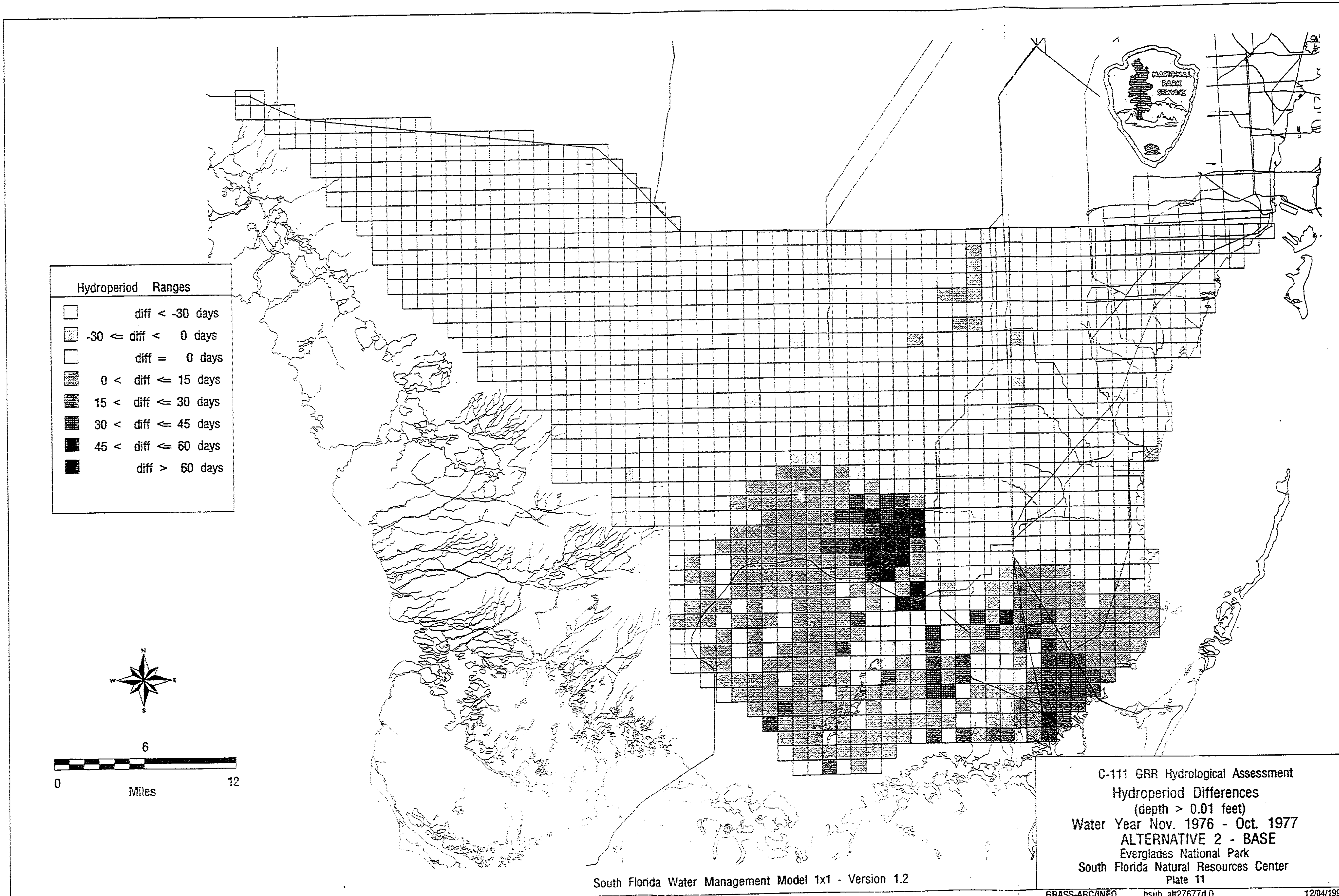


C-111 GRR Hydrological Assessment
Hydroperiod
(depth > 0.01 feet)
Water Year Nov. 1976 - Oct. 1977
BASE
Everglades National Park
South Florida Natural Resources Center
Plate 9

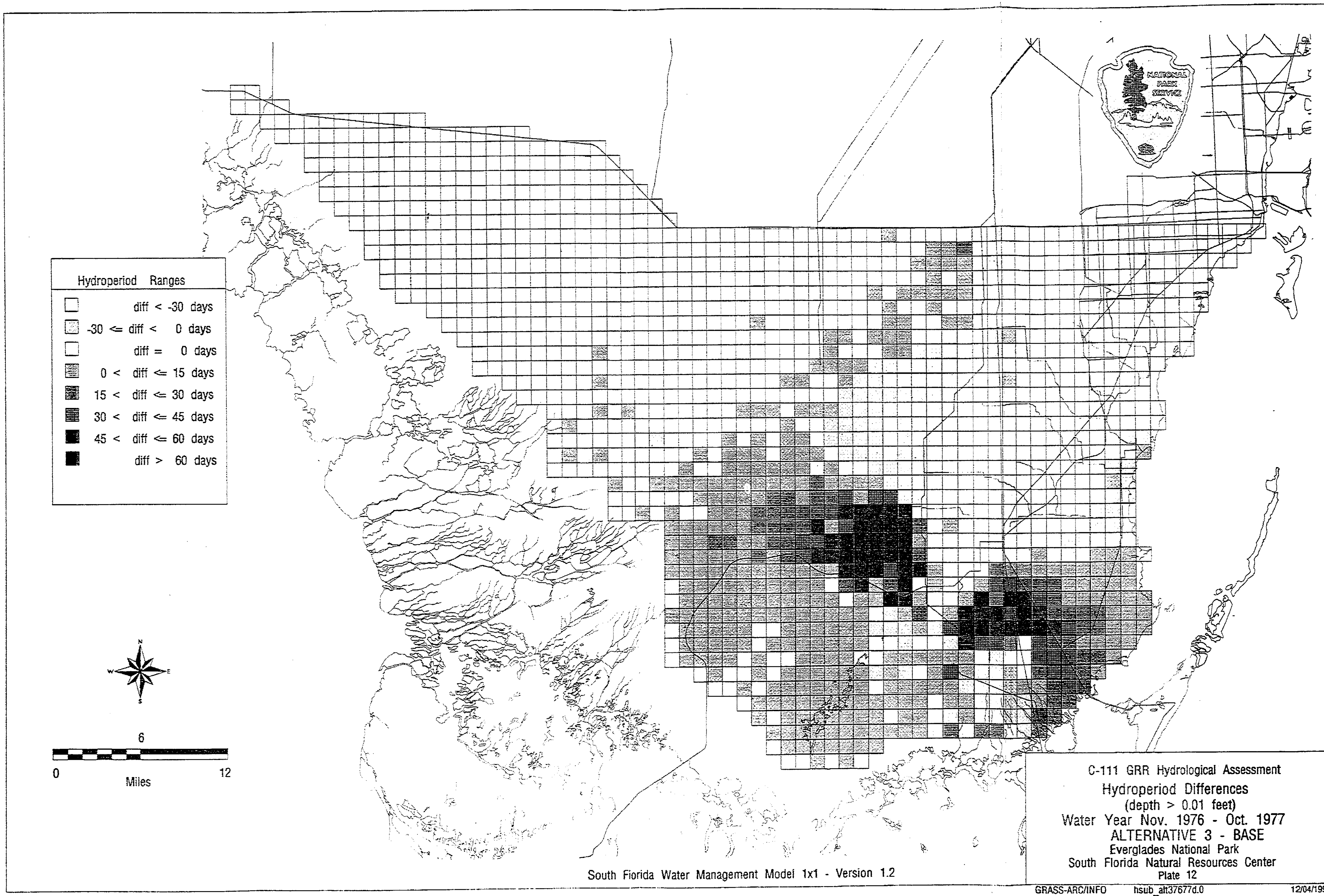
GRASS-ARC/INFO base_hyd7677d.0 12/06/1993



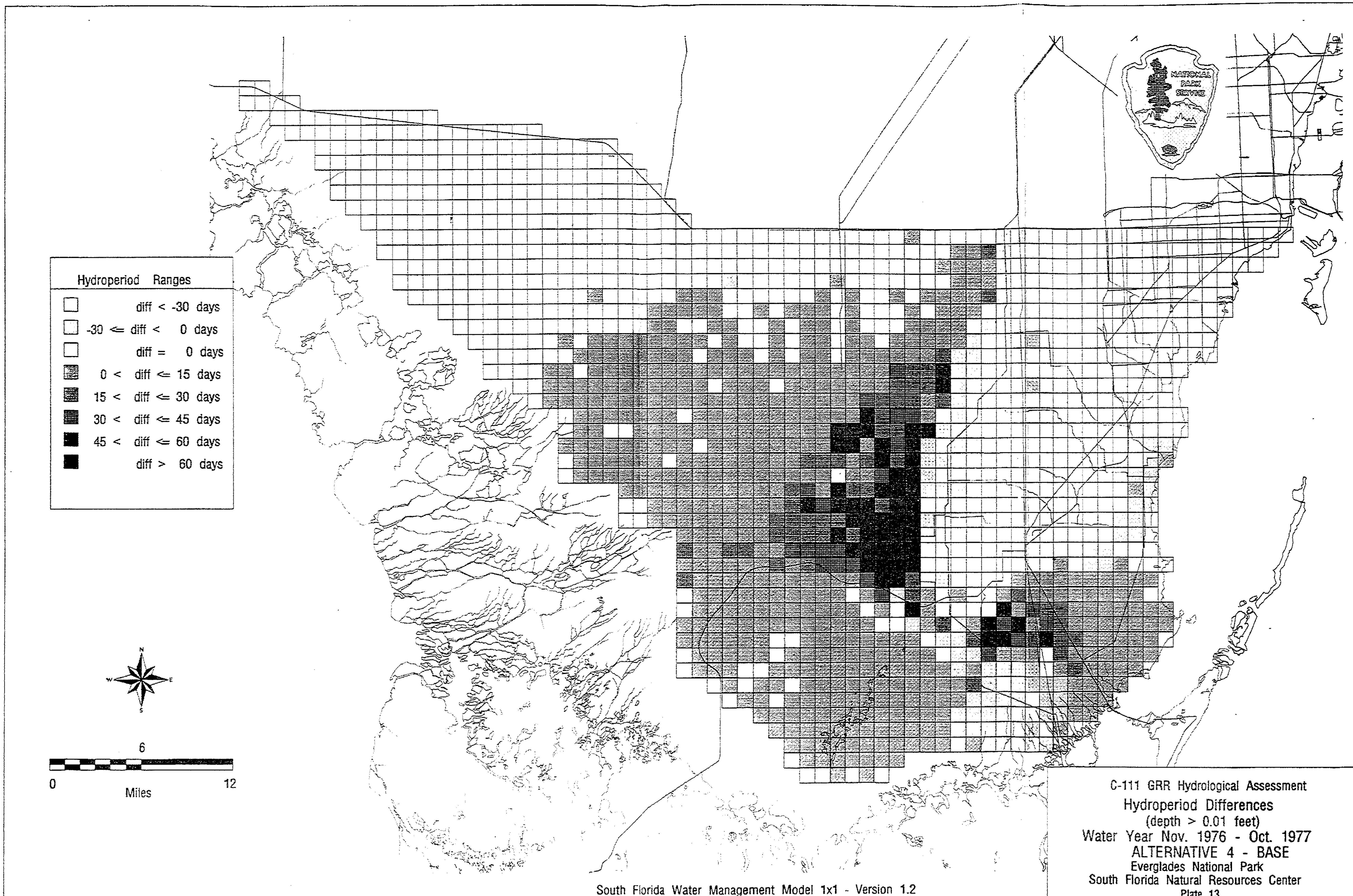
GRASS-ARC/INFO hsub_alt17677d.0 12/06/1993



Hydroperiod Ranges
diff < -30 days
-30 <= diff < 0 days
diff = 0 days
0 < diff <= 15 days
15 < diff <= 30 days
30 < diff <= 45 days
45 < diff <= 60 days
diff > 60 days
NATIONAL PARK SERVICE
6
0
Miles
12
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Hydroperiod Differences
(depth > 0.01 feet)
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 2 - BASE
Everglades National Park
South Florida Natural Resources Center
Plate 11
GRASS-ARC/INFO
hsub_alt27677d.0
12/04/1993

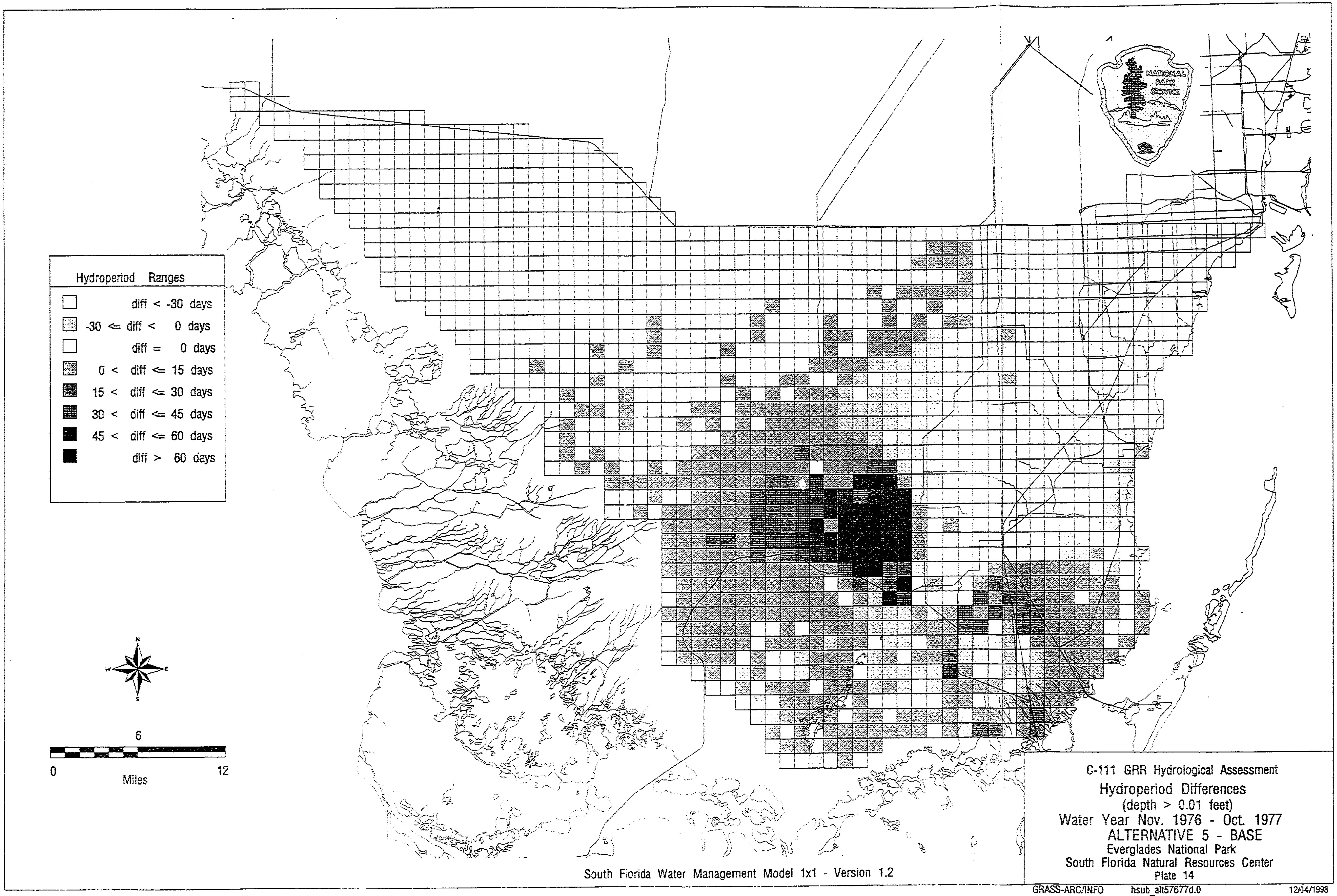


NATIONAL PARK SERVICE
Hydroperiod Ranges
diff < -30 days
-30 <= diff < 0 days
diff = 0 days
0 < diff <= 15 days
15 < diff <= 30 days
30 < diff <= 45 days
45 < diff <= 60 days
diff > 60 days
N
W
E
S
6
0
Miles
12
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Hydroperiod Differences
(depth > 0.01 feet)
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 3 - BASE
Everglades National Park
South Florida Natural Resources Center
Plate 12
GRASS-ARC/INFO
hsub_alt37677d.0
12/04/1993

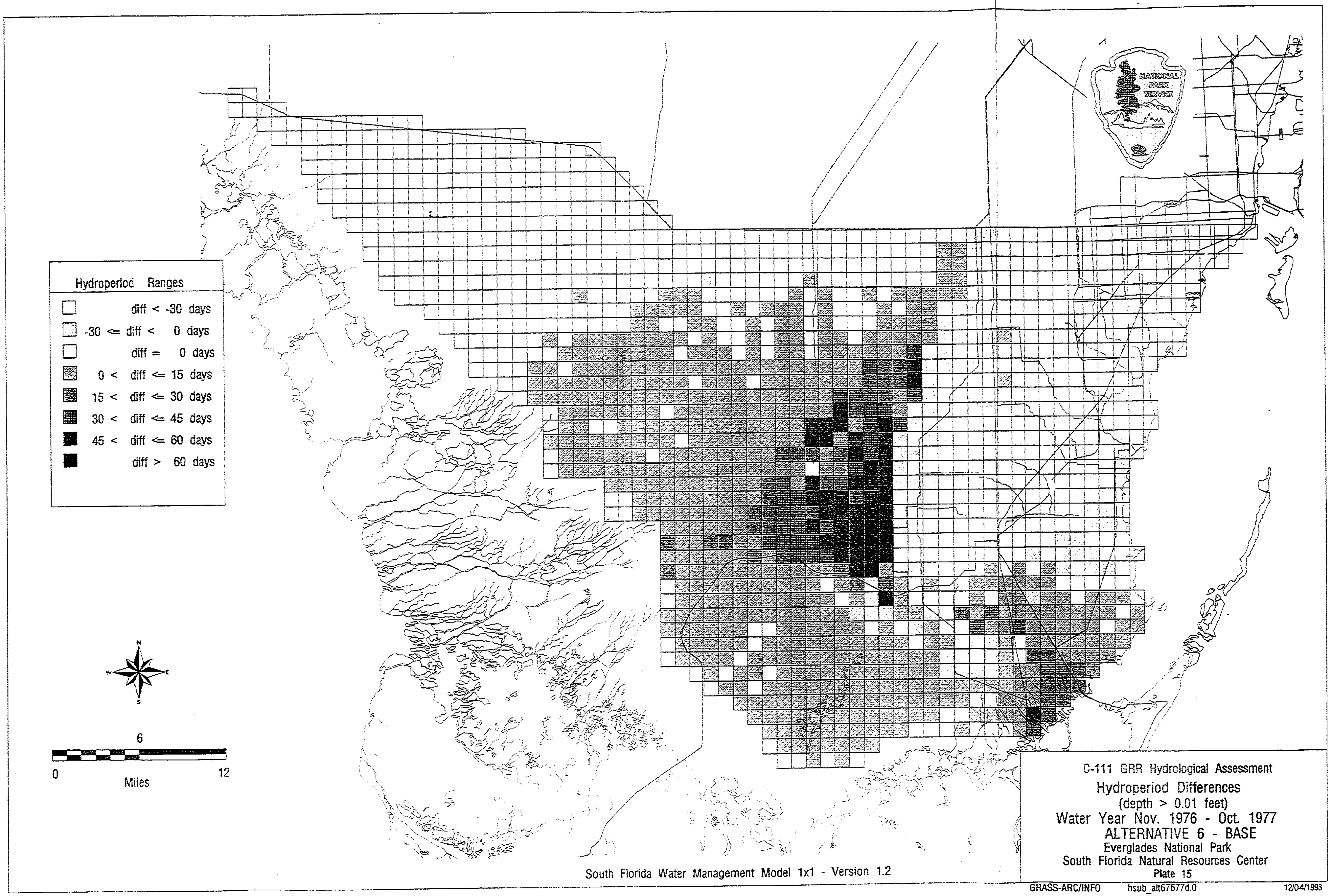


C-111 GRR Hydrological Assessment
Hydroperiod Differences
(depth > 0.01 feet)
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 4 - BASE
Everglades National Park
South Florida Natural Resources Center
Plate 13

GRASS-ARC/INFO hsub_alt47677d.0 12/04/1993



Hydroperiod Ranges
diff < -30 days
-30 <= diff < 0 days
diff = 0 days
0 < diff <= 15 days
15 < diff <= 30 days
30 < diff <= 45 days
45 < diff <= 60 days
diff > 60 days
NATIONAL PARK SERVICE
N
W
E
S
6
0
12
Miles
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Hydroperiod Differences
(depth > 0.01 feet)
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 5 - BASE
Everglades National Park
South Florida Natural Resources Center
Plate 14
GRASS-ARC/INFO
hsub_alt57677d.0
12/04/1993



Hydroperiod Ranges
diff < -30 days
-30 <= diff < 0 days
diff = 0 days
0 < diff <= 15 days
15 < diff <= 30 days
30 < diff <= 45 days
45 < diff <= 60 days
diff > 60 days
N
W
E
S
6
0
12
Miles
NATIONAL PARK SERVICE
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Hydroperiod Differences
(depth > 0.01 feet)
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 6 - BASE
Everglades National Park
South Florida Natural Resources Center
Plate 15
GRASS-ARC/INFO
hsub_alt67677d.0
12/04/1993

11 Conclusions

The following sections summarize the analysis of the previous sections.

11.1 Summary of Canal Stage and Flow Comparisons

Under the Base condition and Alternative 1 the majority of the outflows from the L-31N basin pass eastward through the C-102 and C-103 canals. This is contrary to the original design operations of the south Dade canal system, and represents a significant loss of water from the regional system. This problem is substantially reduced under Alternatives 2 through 6, which redirect these flows westward into Taylor Slough, via S-174 or the new S-332A-D pumps. All of these alternatives greatly increase flows into Taylor Slough. Alternatives 1, 2, and 5 discharge into the main channel of Taylor Slough, using large pumps located at a single location. In contrast, Alternative 3 discharges into the Frog Pond, and has culverts which spread flows out along the L-31W canal. Alternatives 4 and 6 use five moderate size pumps to spread water out over the wetlands of the Rocky Glades and northern Taylor Slough. Unfortunately all of these flow increases are created by substantially lowering L-31N wet season canal water levels well below the Base condition, particularly during the months of August through October. This leads to over-drainage of the wetlands in the Rocky Glades and northern Taylor Slough.

Wet season inflows into the lower C-111 basin are greatly reduced under all of the plans, since S-176 is essentially not used to pass runoff southward into the C-111 basin except during the dry season. This has the benefit of redirecting flows westward into Taylor Slough, but will result in drier conditions in the Eastern Panhandle basin. Moderate discharges are made through S-177 into the lower C-111 basin during most years, with larger flows occuring during periods of high wet season rainfall (such as in 1981 and 1989). Under Alternatives 3, 4, and 5 flows through S-177 significantly increase, as a result of the addition of a 500 cfs pump at the C-500E spreader canal. Alternatives 4 and 6 tend to lower average S-177 wet season water levels because most of the excess L-31N runoff is pumped into the marshes north of the Frog Pond. In contrast, alternatives 2, 3, and 5 pass the excess L-31N runoff into Taylor Slough through a degraded L-31W canal or via the Frog Pond. This causes water levels to increase in the eastern portion of the Frog Pond, which contibutes groundwater seepage to the C-111 canal, and maintains higher water levels upstream of S-177. Alternatives 3 and 4 tend to raise wet season canal water levels downstream of S-177, while Alternatives 1, 2, and 5 show only minor differences from the base condition. This suggests that alternatives that discharge excess L-31N runoff into Taylor Slough at locations as far south as S-175 have the likelyhood of loosing this water due to groundwater return flow to the C-111 canal downstream of S-177.

Under Alternatives 1, 2, and 6 the S-332C pump (which discharges into the C-500E spreader canal) is limited to 50 cfs, so the discharges remain small, and all excess runoff is passed through the existing S-18C structure. Under Alternatives 3, 4, and 5 the S-332B/E pump is increased to 500 cfs, so the discharges are large, and have a significant impact on the downstream marshes. Average wet season outflows from the lower C-111 canal increase significantly under Alternatives 2, 3, and 5. This suggests that excess runoff from the C-111 basin can be effectively removed through the addition of the C-500E spreader canal and a large capacity pump. Large freshwater releases (some in excess of 30,000 acre-feet) are made through S-197 into Manatee Bay during the years with high wet season rainfall under Alternatives 1, 2, and 6 that leave the lower C-111 canal intact. Rapid influxes of freshwater are known to have detrimental impacts on the downstream estuarine biota, and the discontinuation of S-197 releases has been a major driving force prompting the development of the C-111 GRR.

Our wet season water budget analyses indicate that during high rainfall years such as 1968 and 1969, Alternatives 2 through 6 drain tremendous volumes of runoff from the L-31N canal system. Alternative 5, in particular, drains more that 110,000 acre-feet from the L-31N canal system during each of the 1968 and 1969 wet seasons. This is more that 50,000 acre-feet in excess of the Base condition. Again the source of most of this water is the over-drainage of the marshes of the Rocky Glades.

Supplemental dry season pumping at S-331 averaged approximately 14,400 acre-feet, and peaked at just under 32,000 acre-feet for the 25-year simulation. These figures are approximately 5% of the volumes estimated by the Corps in their 1973 GDM for the South Dade Conveyance System [U.S. Army Corps of Engineers, 1973]. Dry season inflows into the L-31W and C-111 canals are inadequate to meet the Congressionally mandated Minimum Delivery Schedules. Average dry season canal water levels in the L-31N and C-111 canals show that under the Base condition and all of the alternatives, canal stages fall well below the established dry season minimum stages. Clearly, the C-111 GRR modeling has not captured the authorized operational practices of the SDCS.

11.2 Summary of Marsh Flowline Comparisons

In general, groundwater flows through the wetlands made up slightly over 50% of the total annual flows at the Rocky Glades flowline, but the percentage decreased downstream, accounting for 10% or less at the flowlines within southern portions of Taylor Slough and the Eastern Panhandle basins. For the Base condition and all of the alternatives, approximately 75% to 85% of the total annual surface water and groundwater flows occurred during the wet season. The seasonal flow reductions occured rapidly so that by December, there was very little flow passing through the wetlands and into the downstream estuaries. Under Alternatives 4 and 6, surface water flows at the Context Road flowline were significantly increased, particularly during high rainfall years. These changes are a response to the direct marsh inflows from the proposed S-332B and S-332C pump stations.

Average annual surface water flows at the Taylor Slough Bridge flowline were approximately 44,000 acre-feet under the base condition, and increased slightly under all of the alternatives. Flows under Alternative 1 showed the greatest impact in response to the proposed enlargement of the existing S-332 pump station. Average annual surface water flows along the lower Taylor Slough flowline were approximately 69,000 acre-feet under the Base condition, and all of the alternatives, except 3 and 5, produced a slight increase of up to 10%.

Under the Base condition and Alternatives 1, 2, and 6 surface water and groundwater flows through the upper Eastern Panhandle flowline are generally insignificant. In contrast, surface water flows are increased significantly under Alternatives 3, 4 and 5, which include the installation of a proposed 500 cfs pump at the intersection of C-111E and the new C-500E canal. At the southern flowline average annual surface water flows were approximately 74,000 acre-feet under the base condition, and increased by slightly more than 10% under Alternatives 3 and 5. Again, groundwater flow contributed approximately 10% of the total annual flow.

11.3 Summary Stages and Hydroperiods at Selected Monitoring Points

Within the developed areas east of the L-31N and C-111 canals, water levels remained more than 1.5 feet below the ground surface throughout all of the model runs. Alternatives 2 through 6 tend to slightly lower wet season water levels at G-855, S-196A, and G-789 during most years. This suggests that the increased outflow capacity provided by large pumps can provide a slight improvement in the level of flood protection in these areas. At G-613 in the C-111E basin, wet season water levels tended to rise slightly (particularly under Alternatives 3 and 5), in response to the maintenance of higher water levels in the Frog Pond.

Water levels in the developed areas west of these canals are more variable, but all of the structural plans examined show high groundwater levels during the wet season, and short periods of surface water flooding are predicted in the agricultural areas of the Rocky Glades and the Frog Pond during periods of high wet season rainfall. In the Rocky Glades developed areas Alternatives 2 through 6 slightly lower wet season water levels compared to the base condition, in response to the increased outflow capacity in the L-31N canal. In the Frog Pond, Alternatives 4 and 6 tend to lower wet season water levels, while Alternatives 2, 3, and 5 significantly raise wet season water levels. All of the developed areas west of the Eastern Protective Levee System have a significant risk of flooding due to the low-lying nature of these lands, and their close proximity to the Everglades.

The marshes in the upper Taylor Slough basin experience surface water flooding for 3 to 9 months each year under the base condition and the proposed alternatives. The water depth and hydroperiod changes vary quite a bit in this area in response to differences in the location of structure inflows. All of the alternatives produced increases in wet season water levels, but provided only modest hydroperiod improvements. In the lower Taylor Slough basin water levels and hydroperiods showed almost no change under any of the alternatives.

In the impounded wetlands north of the lower C-111 canal, alternatives 1, 2, and 6 slightly lower wet season water levels while alternatives 3, 4, and 5 significantly lower wet season water levels. This is presumably a result of the removal of the northern levee, which is used as fill to completely or partially backfill the lower C-111 canal. In the marshes south and west of the lower C-111 canal water levels and hydroperiods show no significant changes during the wet season under any of the proposed alternatives. During the dry season, water levels tend to be lower under all of the alternatives that backfill the C-111 canal. The modeling results confirm that the marshes north of the C-111 canal have substantially higher wet season water levels, and maintain much longer hydroperiods then the wetlands south and west of the C-111 canal. This is a result of the levee system along the northern and eastern side of the lower C-111 canal, which holds back wet season runoff. Under natural conditions this area would have provided sheetflow to the downstream marshes and Florida Bay.

12 Recommendations

To provide environmental benefits to the wetlands of Everglades National Park any proposed structural and operational changes must show a reversal of the on-going drainage. None of the alternatives offered to the Park for evaluation showed any significant increase in hydroperiods and hydropatterns. Restoration goals of returning the wetlands to pre-project conditions at a minimum (*i.e.*, increasing stages in the natural areas and allowing the proper seasonal fluctation of these stages) remain elusive under the alternatives. Seasonal fluctuations of surface and ground water levels at the 21 monitoring gauges, computed for the entire 25 year model period, barely show any increase at all. Spatial water depth differences between base and the alternatives, show slight depth increases in the areas adjacent to the pump discharges, but low canal stages cause large seepage losses back into the canal. The significant environmental benefits of the project are not related to restoration of the wetlands, only a fraction of the wetlands receive increases of more than 0.3 ft. With Alternative 3 the annual average end-of-month surface water depths increases are greater than 0.03 ft. over an area of only 10 mi^2. Projected necessary increases in stages in the wetlands west of the confluence of C-111 and L-31W range from 0.5 ft. in the dry season to more than 2.0 ft. in the wet season [Lent and Johnson, 1993a]. Flow comparisons for the model using the base and alternatives indicate relatively modest increases in surface and ground water flows across flowlines located across selected locations in the Park.

Restoration of the Everglades cannot begin without looking at modest increases in water level to approach pre-project or pre-drainage conditions. Unless alternatives which mimic a more natural Everglades are designed and tested, any proposed project has a good chance of failing to provide hydrological benefit to the majority of the natural areas under consideration. To promote sheetflow, discharge to the wetlands requires the use of many entry points to maintain the high stages in areas adjacent to the levees and farther into the sloughs. Large pumps at specific convenient discharge points serve to expedite the release of flood control waters and provide the ability to expand their use for continued drainage operations during the end of the wet season. The use of smaller pumps of the total capacity necessary for flood control and spaced at many locations, such as the pumps in Alternative 4, with the surge pool and storm water treatment area, such as those in Alternative 3, buffering the natural system from the developed areas, would continue to provide the necessary flood protection. These concepts also make it possible to implement the higher wetland stages and to allow the proper seasonal fluctuation of these stages to meet restoration goals. The use of detention/retention areas would also reduce large flood control releases to Manatee Bay, and retain the water for slow release to the wetlands. These areas provide a small increase in local storage capacity and will maintain higher wetland stages into the early part of the dry season. Detention areas discharge water into the wetlands through pumps, culverts or spillways, while retention areas discharge waters into the wetlands through groundwater and levee seepage, thus releasing the flood waters slowly over a longer time period. Impoundment areas constructed adjacent to the wetlands and serving as a buffer zone between the developed and the natural areas can function as these detention/retention basins.

The high conductivity of the surficial limestone aquifer in the C-111 basin makes it difficult for developed areas requiring low ground water levels to coexist immediately adjacent to natural areas which require high surface and ground water levels. A buffer zone can serve as a transitional land area where water levels step down gradually from the west to the east. Parts of this buffer zone can serve as detention and retention lands for flood control purposes, and also serve as filtration lands for the runoff from developed lands. Authorized levels of flood protection would exist as originally proposed, designed and built for the lands east of the Eastern Protective Levee System, while areas within the buffer zone, but outside the mostly wet detention/retention areas, would experience frequent surface water inundation, especially during the wet season.

Design of a project for environmental purposes needs to include the operational flexibility to allow iterative refinement of the operational procedures. Benefits in the natural areas cannot be determined in the same fashion as benefits for a flood control project, where the process consists of the sizing of a pump and the selection of a convenient discharge point. Hydrological assessments for environmental benefit done in a swamp must look at the temporal and spatial patterns of surface water. To implement this process the operation of the system as well as the structural modifications must be included. It is unfortunate that the limited GRR timeframe allowed only the testing of proposed alternative plans under the established base operational criteria. With the addition of larger canals and larger pump capacities, the entire C&SF Project should be operated differently for both flood control and water supply purposes. These changes should be addressed during the evaluation process, not established after the preferred alternative is selected. Operational criteria must be locked in as part of the entire process, otherwise the preferred alternative may not work for most of its intended purpose (viz. the L-31W canal).

Following the guidelines established for the evaluation of the alternatives and the realization that restoration efforts for ENP must use a holistic approach, the Park's staff is providing a conceptual approach of an alternative which addresses the issues of stage restoration in the headwaters of Taylor Slough and NESS, principally by the reintroduction of surface water at multiple entry points, the establishment of detention and retention areas, and a buffer zone. Since none of the alternatives address wetland restoration sufficiently, the Park's staff is including a conceptual plan, Alternative 8, which incorporates the findings of the analysis contained in this report.

12.1 Concepts of Alternative 8

Using several of the alternatives offered for consideration, particularly the features offered in Alternatives 3 and 4, the Park's staff have revisited the structural proposals to more fully include benefits for the Park's water resources. To assess this plan and, if desired, the previously offered alternatives, operational guidelines have to be established during the continued evaluation process. An iterative process is needed in order to fully document and evaluate the system's response to both the structural and operational modifications.

Alternative 8 has as its main goal restoration of the stages in the natural areas of the C-111 basin. To this end a buffer zone is added to provide the GRR's desired flood control improvements, while maintaining higher water levels in the adjacent wetlands of the Rocky Glades and northern Taylor Slough. Present and future concerns about water quality and the need for detention/retention areas, to hold excess storm water, require the construction of impounded areas which can serve this function. Not all of the lands within the buffer zone can be used or are required for use as detention/retention zones. However, landuses that are incompatable adjacent to a wet Everglades probably will not function well in the buffer zone. Also, a substantial connection with Water Conservation Area 3B is included in this plan. This connection is proposed in the form of large flow ways or control structures to meet ENP goals to restore Northeast Shark Slough (NESS) to a functioning wetland. Flow into NESS will undoubtedly affect the stages in the headwaters of Taylor Slough and has to be included in the evaluation process, since the needs for additional flow capacity to NESS has not been adequately addressed in the Corps Modified Water Deliveries GDM.

The conceptual details of this alternative are divided into a structural component and an operational component, the details are as follows (see Fig. 50):

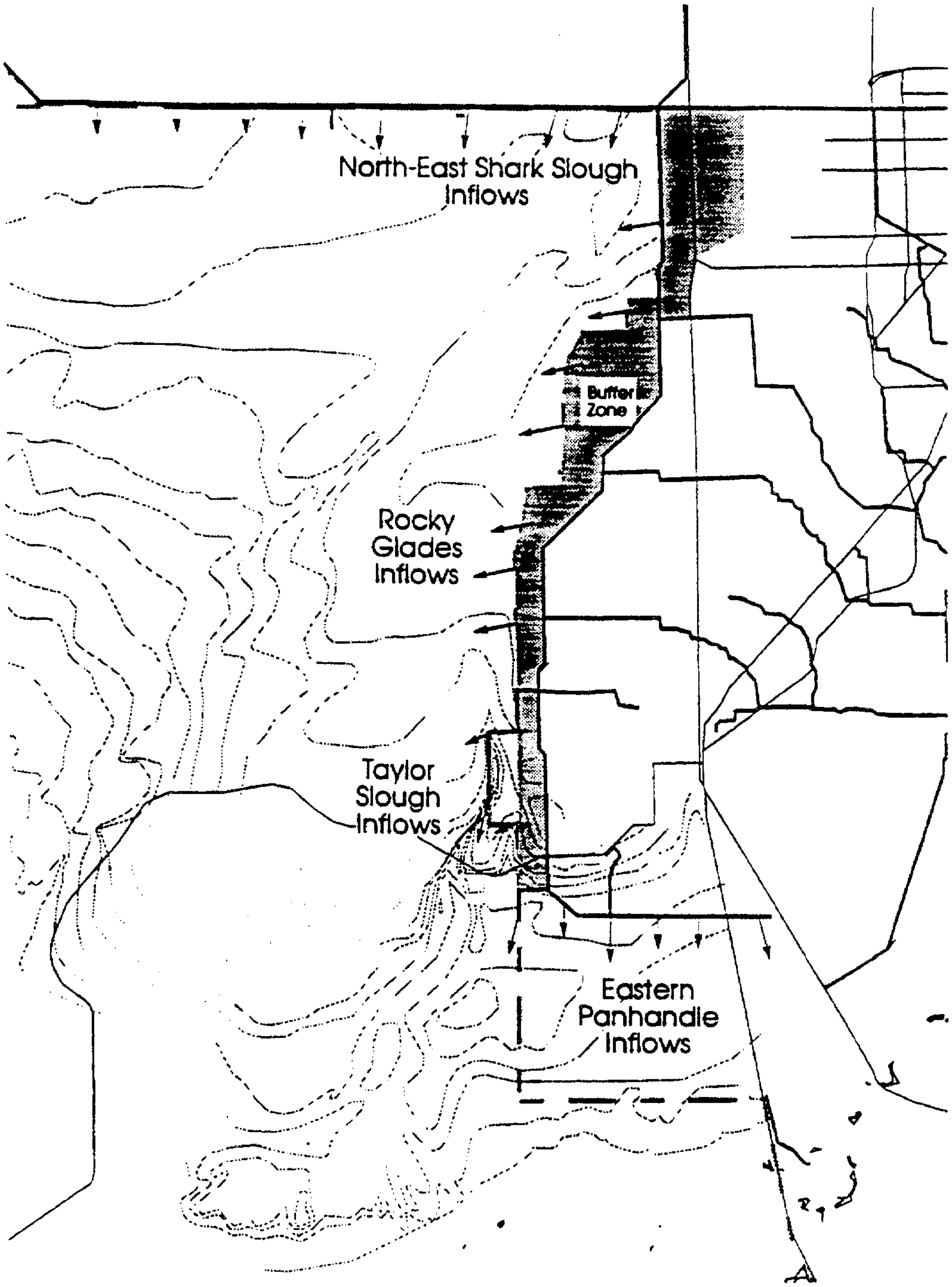


Figure 50: Proposed Alternative 8

- Structural Component
  - Eliminate or degrade L-67A and C in the water conservation areas, to allow sheetflow to occur for delivery to NESS.
  - Construct several large flow ways or water control structures across Tamiami Trail to provide water supply for Northeast Shark Slough.
  - Eliminate L-67E and remove structural components.
  - Constuct a levee from the north end of the 8.5 sq mi. area to a point south of S-175 and create a buffer area between L-31N/C-111 and the levee.
  - Compartmentalize some or all off the developed and natural lands within this buffer zone to serve as retention/detention areas.
  - Provide the necessary pumps to maintain the authorized levels of flood control to lands east of the EPLS and let this excess water discharge into detention or retention areas west of the levees.
  - Discharge water supply to the wetlands through multiple points from the detention areas.
  - Pass all storm water runoff into detention/retention basins within the buffer zone prior to discharging into the natural wetlands.
  - Eliminate L-31W, C-109, C-110 and C-111 south of the confluence with C-111E and remove structural components.
  - Construct a new canal, the Spreader Canal from C-111E east across US-1 (C-500E).
- Operational Component
  - Maintain pre-project stages in the wetlands including the areas along the entire Eastern Protective Levee System.
  - Restore authorized canal levels in L-31N and C-111.
  - Retain L-31N basin runoff for discharge to the west instead of through the Coastal Ridge canals (C-102 and C-103).
  - Implement rainfall based formulas for discharges into NESS, the Rocky Glades, Taylor Slough and the Eastern Panhandle based on wetland water level targets.
  - Allow flow deliveries to occur from the north (via S-331) into L-31N when needed to maintain canal/marsh water levels.

The design of pumps for flood control will be accomplished by the Corps and SFWMD. For the natural areas west of the buffer strip the emphasis is on stages, the SFWMD and COE should perform the work to compute flows necessary to accomplish the stage targets. Target stages recently computed for the headwaters of Taylor Slough (see [Lent and Johnson, 1993a]) are reproduced here as guidelines (Fig. 52). The stages from the long term record at G-789 are intended to be applied to the marsh gauge on Context Road (G-3115). The detailed development of wet and dry season operations, implementation of rainfall formulas will be done jointly by the ENP, COE and SFWMD.

A typical detention/retention area is shown in Fig. 51. This is a conceptual plan and complete details of this plan need to be worked out to include all the uses of the C&SF Project. Alignments of detention/retention basins, pumping capacities, locations of spillways and culverts should be refined during the evaluation process. The principle is to allow flood waters (Fig. 53) to be pumped into the detention areas and be discharged from this area through culverts and spillways and overbank flow. Water supply (Fig. 54) would be met through pumps and overbank flow. All flood control and water supply waters would enter the wetlands through the detention/retention areas.

An evaluation of this alternative through the use of a natural version and the management version of the SFWMM model is required to refine the conceptual approach and to test structural components and operational procedures and their effects on the Park.

Prioritization of the areas of immediate concern, those which provide the greatest immediate benefit cannot be ascertained in the extremely short time allowed for the re-evaluation phase of the process. As water supply conflicts such as the development of a West Dade wellfield illustrate, the process of resolving regional water supply issues may best be coordinated with all the on-going planning, evaluation and design processes. Such a process will aid considerably in the management of South Florida's precious resource. The piecemeal processing of regional water supply and flood control issues will only lead to future failures.

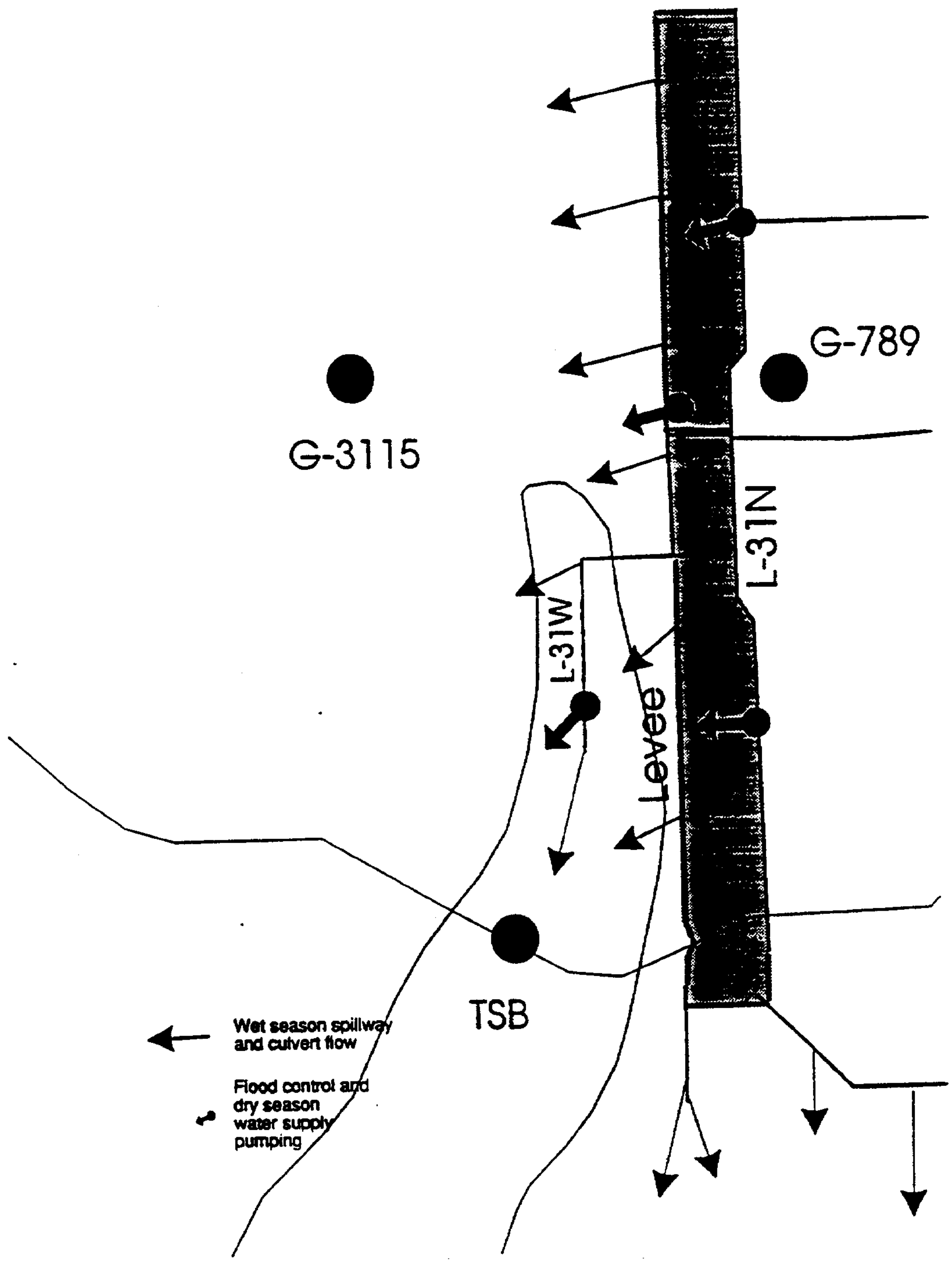


Figure 51: Detention/Retention Area in the Frog Pond

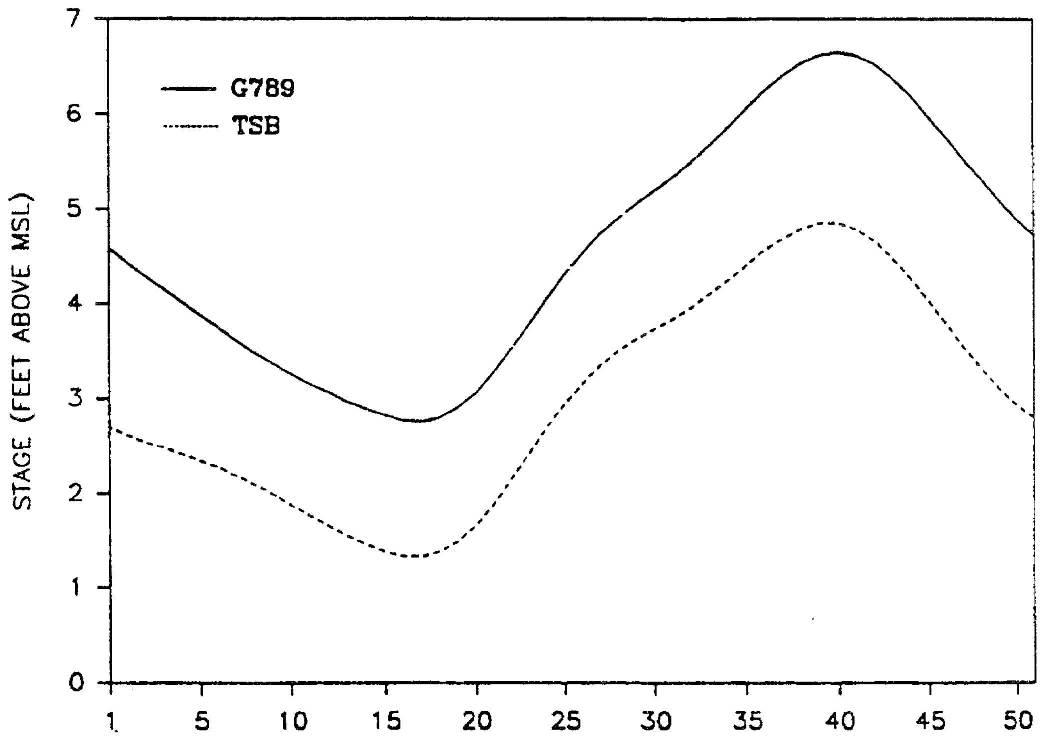


Figure 52: Target Stages in Taylor Slough

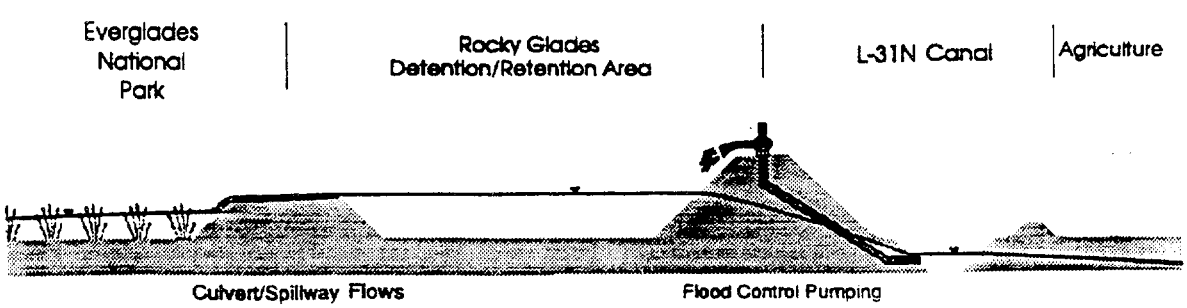


Figure 53: Cross Section across a Typical Canal and Levee System

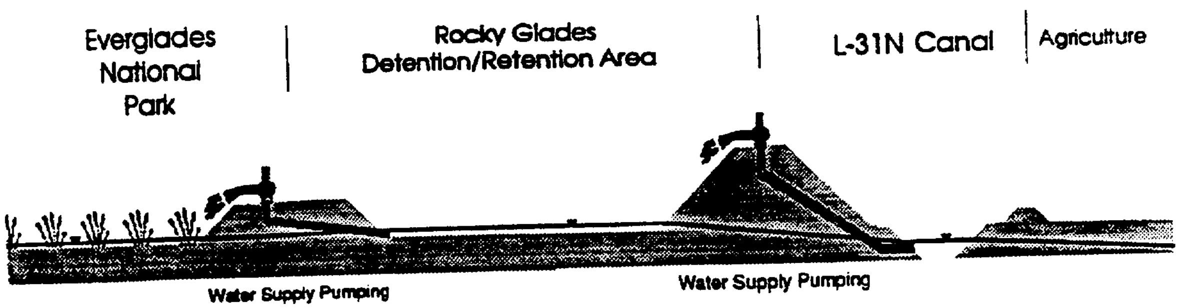


Figure 54: Cross Section across a Typical Canal and Levee System

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Technical Report SFNRC 93–4

Appendix A

National Park Service
Everglades National Park
South Florida Natural Resources Center

February, 1994

A Introduction

This appendix is intended to provide a more detailed hydrological assessment of the principal subbasins within the C-111 drainage basin and to illustrate the need to include necessary structural modifications to the C&SF project for environmental benefit. Justification of the need to include detention/retention areas and a wider spatial distribution of pumps and culverts is addressed. The analysis contained herein also addresses questions raised during the U.S. Army Corps of Engineers' Project Review Conference and evaluates the modifications of Alternative 6 as proposed by the Corps. The results of this analysis intend to show the regional effects that the changes in water deliveries brought about by each of the proposed alternatives will have on the natural areas within each subbasin.

The spatial data used in this appendix are also based on the South Florida Water Management District's model (SFWMM-1x1, see section 4). The SFWMM-1x1 is a regional model with a 1 mile by 1 mile grid resolution. Some of the detail proposed in the alternatives and specifically the changes proposed to Alternative 6 are of smaller spatial resolution than the model is capable of capturing. Details of the levee locations, the proposed detention/retention basins, and exact pump locations cannot be evaluated until modeling efforts using finer grid resolutions are completed. The Park anticipates that these studies will be done during the next phase of the proposed project. Also, during this next phase the necessary operational changes and water supply issues must be discussed and evaluated. The following analysis was completed using the output from Alternatives 1 through 6 and are only intended to show a regional comparison, *i.e.*, changes occuring in subbasins as a whole, between each alternative and the base condition.

A.1 Subbasin Areas

The boundaries of the subbasins used in the analysis of the SFWMM-1x1 output were selected based on soils, elevation, and hydroperiod information and are shown in Fig. 1. Seven subbasins were used to illustrate the changes:

1) Northeast Shark Slough (NESS) (111 mi^2). The boundary of this subbasin was defined by Tamiami Trail in the north and by the Loxahatchee and Everglades Peats along the northwest and southeast boundaries. The downstream boundary was defined by the 5.0 foot contour line. South of this contour the central portion of the slough looses its definition and expands into a more regional and southwesterly direction.

2) Shark Slough (SS) (78 mi^2). This subbasin continues the flow from Northeast Shark Slough and is bounded near its lower end by East Slough to the northwest and by the higher lands of the Rocky Glades to the east. The lower boundary of Shark Slough coincides with the area where a more dendritic pattern of small streams occurs and eventually flows into well-defined channels, (*e.g.* the Shark River).

3) Rocky Glades (RG) (134 mi^2). Southeast of the Northeast Shark Slough subbasin and east of northern Shark Slough are the higher elevated Rocky Glades underlain with Rockland soils. This subbasin is bounded to the east by the L-31N canal. The southern boundary is defined by the Rockdale sandy soils which underlie the Long Pine Key area.

4) Upper Taylor Slough (UTS) (23 mi^2). The Taylor Slough watershed was divided into two units by the Park Road (State Road 9336). The upper Taylor Slough subbasin was defined by the extent of the Perrine marl soils, which form the upstream extent of the well-defined historical drainage of Taylor Slough.

5) Lower Taylor Slough (LTS) (84 mi^2). This subbasin is receiving flow from upper Taylor Slough and some drainage from Long Pine Key, which flows to the southwest into the ponds and lakes of the upper estuary of Florida Bay. The southern-most portion of Taylor Slough falls outside the model domain, the subbasin's eastern boundary was defined by a rise in elevation which is underlain by Rockland and Perrine marls that separate Taylor Slough from the Eastern Panhandle.

6) Lower Eastern Panhandle (LEP) (36 mi^2). East of lower Taylor Slough the low elevation freshwater and marine marls are divided by the lower reach of the C-111 canal. The lower Eastern Panhandle subbasin is bounded to the east and north by the C-111 canal and flows southerly into the upper estuaries of Florida Bay.

7) Upper Eastern Panhandle (UEP) (50 mi^2). The drainage north and east of lower C-111 is bounded by the Rockdale sandy soils of the Coastal Ridge to the north and Card Sound Road to the east. Since several of the alternatives include flow across US-1, the triangle area to the east was included in this subbasin.

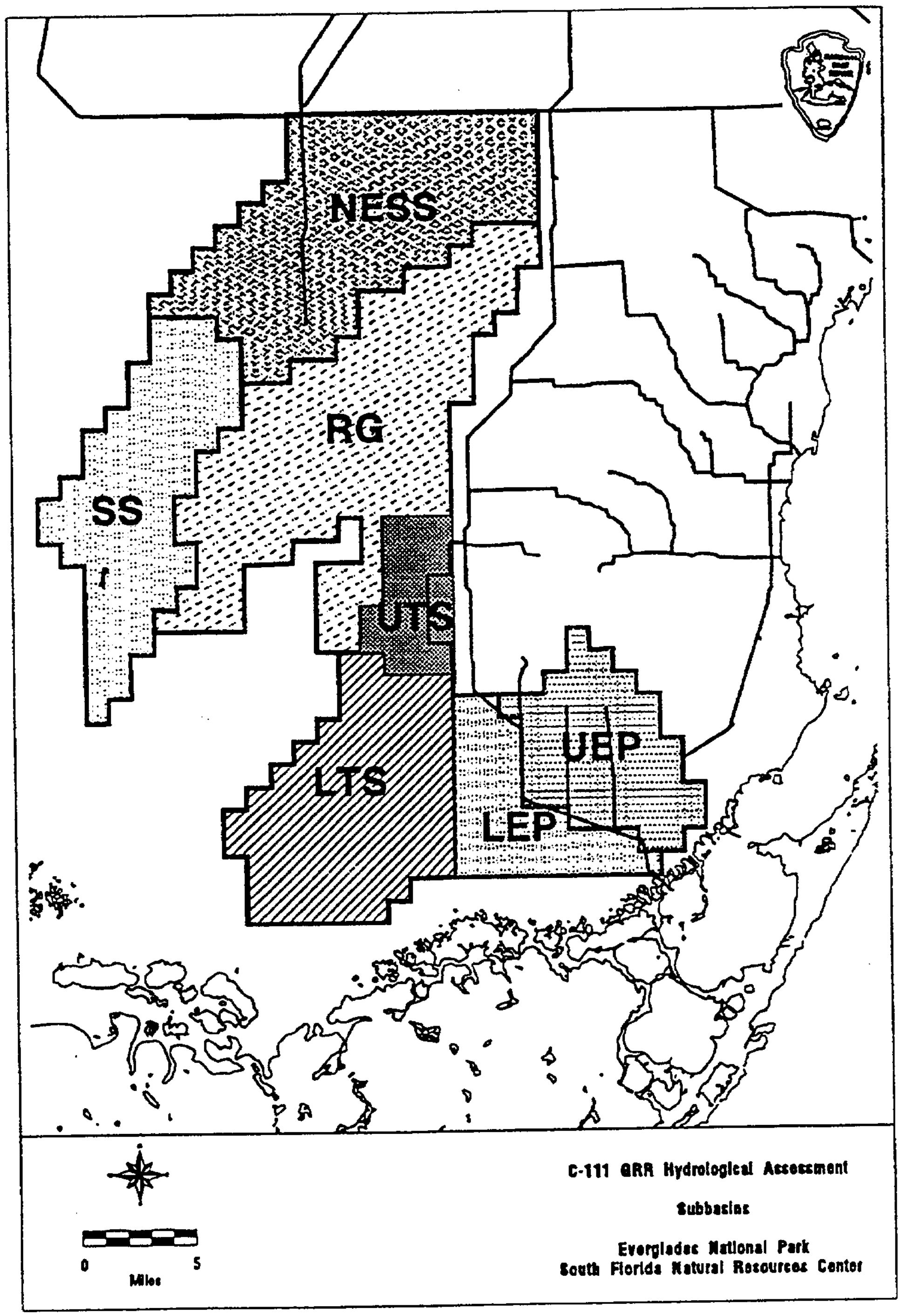

Figure 1: Definition of the Seven Subbasins and their Boundaries.

A.2 Subbasin analysis

The subbasins were used to investigate the impacts of the proposed alternatives on the surface water hydroperiods and water depths of these areas. The daily surface water depths (ponding) for each of the grid cells in the subbasins were tabulated from the same output data files used in section 10 of the main report.

The surface subtractions between each of the alternatives and the base condition for the subbasins is tabulated in Table 1. The average year, 1976–1977, was used herein, but tables containing the data for the typical wet and dry year are published in Appendix B. The following analysis is based on the hydroperiod data contained in Table 10 of the main report. Visual inspection of Plates 9 through 15 also aids in illustrating the hydroperiod changes. Table 1 is subdivided into the seven subbasins, each contains three rows of data. The row labeled "less" are the number of grid cells (or square miles) which have reduced inundation from the base condition, the row labeled "none" contains the number of cells where no change in hydroperiod was observed ($\Delta p = 0$ in Table 10) and the row labeled "more" are the number of cells which have more inundation, thus longer hydroperiods. The following tabulation did not distinguish how long or how deep the changes in water depth were. Generally the increases were quite small (see the color plates for the spatial and temporal categories).

The changes in hydroperiods for the average year, 1976–1977, indicate some of the benefits associated with the wider spacing of pumps as in Alternatives 4, 6 and 6A, which provide multiple discharge points to the wetlands. Both Alternatives 4 and 6 (6A) have four pumps spaced evenly from south of the 8.5 mi^2 area to the north end of the Frog Pond. The increases in hydroperiod in the Rocky Glades show up in 121 and 120 grid cells, respectively, with only 9 cells having reduced hydroperiods. Although Alternative 5 shows an increase in 91 cells, this occurs in the lower portion of the Rocky Glades, while the upper portion shows negative impacts in 34 cells with reduced hydroperiods (see Plate 14). Changes due to detention/retention areas do not show up well in the output, due to the problem of spatial scale. The difference in pump size and location of the alternatives using the large pumps also does not indicate any significant change in hydroperiods in Taylor Slough, whether the water is delivered in the Rocky Glades or discharged as a large volume in Taylor Slough near S-332 or S-174 is not distinguishable in lower Taylor Slough. As might be expected, moving pump capacity farther north affect the upper Taylor Slough subbasin slightly.

Hydroperiods in the Upper Eastern Panhandle subbasin increase due to the addition of the east-west spreader canal. Increases occur in the northern portion of this subbasin, reduced hydroperiods are noted in the southern part. This is probably due to a change in water allocation from lower C-111 to Taylor Slough and from the lower panhandle to the northern portion within the subbasin. The lower Eastern Panhandle subbasin shows a similar pattern, increases in Hydroperiods are generally to the west of C-111 (see Plates 9 through 15), while decreases are noted in the area of the C-111 cutouts. Alternative 4, which takes out lower C-111, actually shows 23 cells with less hydroperiod and only an increase of 12 cells. This pattern is expected. Base conditions allow ponding to occur in the impounded areas north of lower C-111, if the canal is removed and operational changes are not implemented to bring the diverted (to Taylor Slough) water back into C-111, any analysis will show no environmental benefit. This is the reason why recommendations in the main body of the report strongly suggested to discuss and test operational policies.

In addition to the hydroperiod analysis of the subbasins, changes in water depths for April and October for the average year of 1976–1977 (Table 2) is used to illustrate the seasonal changes occuring in the subbasins. Tables containing the data for the typical wet and dry year are published in Appendix B. Due to the time constraints, only Alternatives 1, 4 and 6 were used to compare against the Base condition. The table is similar to the hydroperiod table (Table 1), the tabulation is of average monthly (obtained from daily data) water depth changes between each alternative and base. During 1977, April is the driest month and October is the wettest month, this pattern is similar to the dry and wet years shown in the appendix.

During April, most of the C-111 basin is dry under base and any alternative, it is not clear at this time why the data shows that there are higher surface water levels in Northeast Shark Slough and Shark Slough. During the wet month, October, both Alternative 4 and 6 show water depth increases in the Rocky Glades, Northeast Shark Slough and Shark Slough. Water depth increases in these areas with Alternative 1 are much smaller, illustrating again the benefits of using multiple entry points. Water introduced north of and in the headwaters of Taylor Slough regardless of location or number of entry points allow both the upper and lower Taylor Slough subbasins to be much wetter during this month.

A.3 Comparison of Alternative 6A and Alternative 8

Alternatives 1 through 6 are discussed and illustrated in section 3 and the conceptual approach of Alternative 8 is located in section 12. A description and evaluation of Alternative 6A is presented in this section. It is again unfortunate that the short timeframe allowed for the follow-up work (one week) does not allow for a more detailed comparison of Alternatives 6A and 8. As the main body of this report concludes, the hydrological benefits in the wetlands, particularly in the lower C-111 basin, must be evaluated with operational changes in mind. Most of the alternatives redirect water that would be delivered into the lower C-111 basin, the Eastern Panhandle, under the base condition and discharge it into the wetlands of the Rocky Glades and Taylor Slough. The hydrological restoration of the wetlands in the Eastern Panhandle are as important as the areas to the north. The rapid releases of fresh water through the lower cutouts into the upper estuary of Florida Bay and through S-197 into Barnes Sound have to be eliminated and the discharges diverted into detention/retention areas. This will aid in the overall process of returning the system to more natural hydroperiods and hydropatterns.

- **Alternative 6A.** This plan is a modification of Alternative 6 and addresses the large seepage losses along the L-31N canal, and the need for detention/retention areas. The components of this plan are shown in Fig. 2 and the specific improvements are discussed below:

  a) A levee would be built approximately 0.5 mile west of L-31N, beginning opposite C-102, but not tied into the levee around the 8.5 mi^2 area. This levee would run southward into the Frog Pond area. The area in between the canal and this levee would serve as a buffer zone to reduce the leakance back to the canal, due to the proposed higher stages in the wetlands to the west.

  b) A second levee would be built approximately 0.5 mile west of the first levee. The area in between the two levees would be a detention/retention area serving as a surge pool for stormwater runoff. This area may also provide water quality benefits by filtering canal water.

  c) Four pump stations, S-332A, S-332B, S-332C and S-332D, with four 75 cfs pumps each, would provide water from L-31N to the detention/retention areas via lined canals across the buffer zone.

d) Eight 36" culverts with stop logs and one 300 ft. emergency spillway would discharge water from the detention/retention area into the wetlands of the Rocky Glades and prevent backflow.

e) The eastern portion of the Frog Pond would be enclosed with levees and S-332D would supply water to the detention/retention area to the north.

f) A new, lined canal would supply water to the existing S-332 pump station (165 cfs) and to the existing structure S-175 (500 cfs). The L-31W canal south of S-175 would remain in place, but the northern section above S-332 would be backfilled.

g) A new spreader canal, C-111N, east of the confluence of C-111 and C-111E supplied by a 50 cfs pump (S-332E) would deliver water to the impounded area north of the lower C-111 canal through overbank flow.

h) The C-109 and C-110 canals would be plugged at regular intervals to induce sheet flow from west to east.

i) The lower C-111 canal would remain in place, but the southern spoil piles would be degraded to allow improved overbank flow southward into Florida Bay.

The concepts of Alternative 8 and its components, discussed in section 12, and shown in more detail in Fig. 3, were endorsed by the Department of the Interior and used as guidelines in evaluating the most recent structural modifications, as defined by Alternative 6A, for this project. In concept, the modifications proposed to supply water to the southern portion of the Rocky Glades and the headwaters of Taylor Slough are similar. Our original transmittal of Alternative 8 did not contain the details of levee and pump placement. Alternative 6A provides more detail on the location to control the seepage problem, but it is clear that additional refinements will be needed during the design phase when detailed analysis is possible, but the use of three levees to stairstep the proposed higher water levels between the canal and the wetlands will retain more water in the wetlands.

The northern Rocky Glades have an improved seepage control system with the addition of the levee, the L-31W tieback, but the proposed levee does not tie in to the 8.5 mi^2 area levee as is proposed in Alternative 8. Problems may occur when the desired increases in water depths in Northeast Shark Slough raise water levels in the northern Rocky Glades. It is conceivable that water levels west of the 8.5 mi^2 area will be high enough that flow will occur

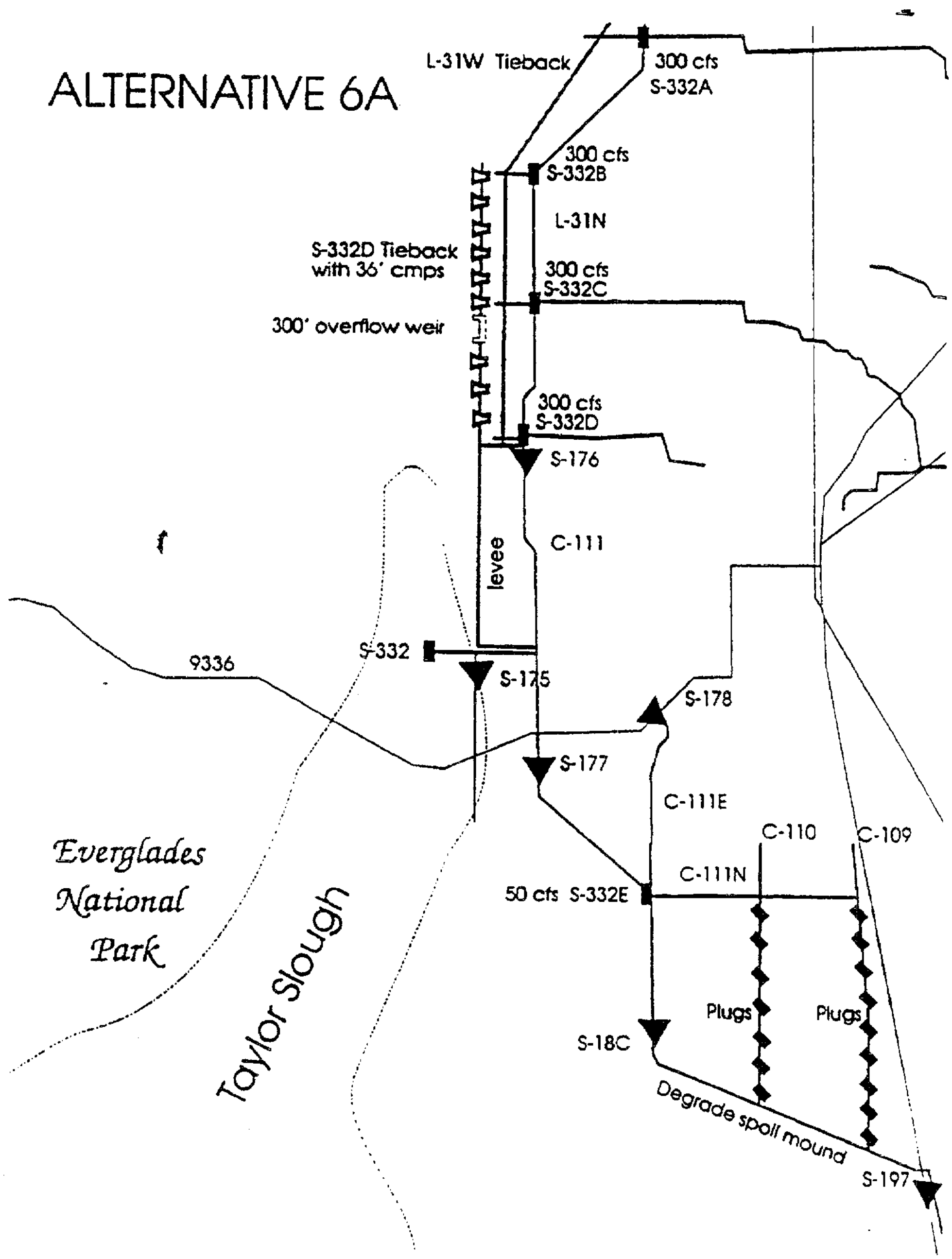

Figure 2: Alternative 6a

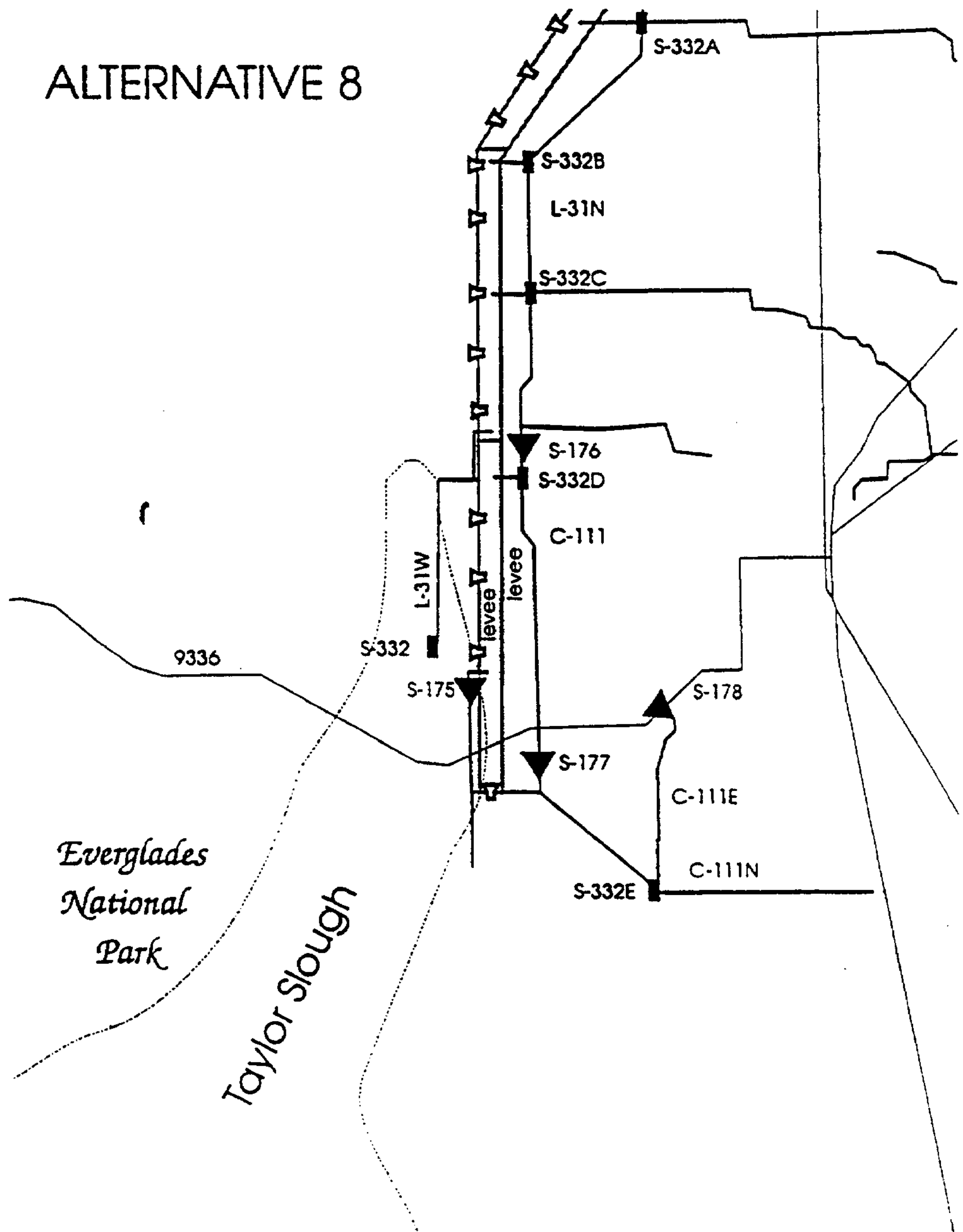

Figure 3: Alternative 8

from west of the levee into the protected area. In this area the C-111 project abuts the Modified Water Deliveries project, and a resolution of the boundary between the two projects is needed. S-332A may be better placed at the soutern terminus of the 8.5 mi^2 area instead of next to L-31N if a continuous levee is built as proposed in Alternative 8, details such as these need to be worked out during the design phase of the project.

Proposed modifications in the Frog Pond differ between Alternative 6A and Alternative 8 in the manner that water is discharged into the adjacent wetlands, and the use of the western Frog Pond as a detention/retention basin. Alternative 6A proposes to pump water to the north detention/retention area and keeps the eastern Frog Pond as a totally enclosed area. Water to the existing S-332 pump and to the S-175 control structure will be delivered through a canal leading from C-111, and the lower end of L-31W would remain. Alternative 8 uses the existing L-31W canal to supply S-332 from the northern detention/retention basin. This would allow overbank flow from the north-south aligned portion of L-31W to occur during the wet season. The lower part of L-31W past S-332 would be filled in down to the S-175 structure. Alternative 8 uses the Frog Pond as a detention/retention area and allows outflows to occur westward. It also uses existing structure S-175 to pass flows from the detention/retention area south through the remaining reach of the L-31W canal for discharge in the wetlands.

The proposed modifications in the Eastern Panhandle are minimal and remain identical to Alternative 6. This region differs the most from Alternative 8. The purpose of the east-west spreader canal without modifications to lower C-111 is not clear. The impounded areas it is intended to supply by the 50 cfs pump are already full of water most of the year and these areas can probably serve as an example, what hydrological restoration of the lower wetlands should look like. The purpose of the spreader canal in Alternative 8 is to replace the lower part of C-111 canal and allow the distribution of water as sheetflow to the marshes farther north. This would meet the original C-111 GRR project goal of eliminating direct freshwater releases to the estuaries via S-197.

A.4 Changes in Flood Protection

All of the alternatives were modeled only as structural improvements and no operational changes were made to the existing system. The optimum wet season water levels are maintained at the structures and outflow capacity is as specified under the authorized project authority. The authority for the General Reevaluation study for the C-111 canal system is tied to the completion

	Design Discharge (cfs)								
	332	S175	S18C	332A	332B	332C	332D	332E	Total
Base	165	500	2100						2765
Alt 6A	165	500	2100	300	300	300	300	50	4015

Table 3: Structure Capacities for Base and Alternative 6A Conditions

of features originally authorized by the 1968 Flood Control Act. This act authorized the construction of the ENP-South Dade Conveyance System, which added new water control structures to the existing canal system for the purpose of conservation and conveyance of water supplies to Everglades National Park, and for expanding agricultural and urban needs. Keep in mind that the 1968 act authorized the SDCS solely for the purpose of increased water supply and improved conveyance, and did not provide the specific authority to increase the level of flood protection within the C-111 canal system.

Table 3 lists the structure discharges for the Base and Alternative 6A condition. Note that this indicates that Alternative 6A provides a 69% increase in total outflow capacity for the C-111 basin. Alternative 8 is a conceptual plan and focuses on elements for environmental benefit, which are stage targets in the wetlands. The sizing of the pumps to maintain authorized levels of flood control must be accomplished by the COE and SFWMD, with this goal in mind. The structures listed in this table are the surface water discharge points into the wetlands and into Barnes Sound via S-197, which is capable of handling all of the S-18C discharges. The tabulation is exclusive of discharges occuring through the coastal canals to the east. To our knowledge these capacities do not change as part of any proposed project.

Alternative 8 eliminates the lower C-111 canal and proposes to transfer the flood control capacity of S-18C to the pumps delivering water into the detention/retention basins and the spreader canal, C-111N. Additonal gravity drainage could be used through emergency spillways at locations along the canal where secondary drainages to Taylor Slough and the Eastern Panhandle exist.

A.5 Conclusions

As requested, a comparison of Alternative 8 and Alternative 6A was made, based on the division of the wetlands into subbasins. The salient points regarding the need to have a buffer zone to control seepage and the need to built detention/retention areas to capture stormwater runoff have been discussed.

The subbasin analysis clearly shows the benefits of spacing the pumps along L31N and C-111 instead of concentrating the capacity at a single point. The model, because of its regional scale, fails to capture the details of the detention/retention areas and the placement of seepage control levees. These must be addressed when finer resolution models are available and other detailed calculations can be made.

As was shown in the body of the report and in the subbasin analysis the benefits associated with the re-introduction of surface water in the Rocky Glades comes at the expense of Base conditions in the Eastern Panhandle. Operational and water supply issues must be addressed in the next phase of the process, to prevent the detoriation of existing conditions in the lower C-111 basin.

ANNEX G

C-111 MARL MODEL BACKGROUND

C-111

PROCEDURE FOR RANKING ALTERNATIVES BASED ON HYDROLOGY AND REPORTED PERIPHYTON-PRODUCING CONDITIONS

C-111 alternatives were ranked by calculating "hydrohabitat units" (HU) for each, based on water depths and frequency of flooding in the "zone of optimum development of marl" (Tabb and Kenny, 1969 - enclosure 1). The maximum, minimum, and average historic water levels reported by Tropical Bioindustries, Inc. (1990) are standards to which we compared projected alternative water levels under three water level exceedance frequencies: 10 percent (wet period), 50 percent (average period), and 90 percent (dry period). The procedure is as follows:

1. Construct a model (marl model) to rate the projected alternative water levels against the reported historic conditions. The model produces 3 values between 0 and 1.0: a value comparing each of the 3 exceedance frequencies to historic water levels under wet, average, and dry conditions.

2. Calculate a hydrohabitat index (HhI)--the cube-root of the product of the 3 model values--for the upper (west) basin and the lower (east) basin under each alternative.

3. Calculate the hydrohabitat units for each alternative. HhUs are the product of the HhI and the square miles with increased hydroperiod--a value for each basin under each alternative. The alternative plans would permit higher water levels in areas larger than the marl zone, and the total area of increased flooding is used in calculating respective alternatives' hydrological units.

<u>NOTES:</u>

CONSIDERATIONS FROM TBI (1990).

Marl soils were formed and maintained under an average hydroperiod of about 7 months.

Water levels may have reached lows of 20-30 inches below ground level. Water recession of from 24 inches to 30 inches below ground level might cause rapid and complete loss of water from marl soils and death of plants.

The average water depth was 8.5 inches over marl soil and ranged from 3.2 inches to 20.9 inches.

Seasonal water depths of 6.5 feet in Shark River Slough (SRS) and the east Everglades in Everglades National Park caused SRS and Taylor Slough waters to meet and flow to Florida Bay.

The model would provide for a hydrohabitat index (HI) value of 1.0 for water depths and conditions as follows:

Depths no less than 0 inches (i.e., ground level) would be exceeded 90% of the time, and

Depths no less than 8.5 inches would be exceeded 50 % of the time, and

Depths up to 21 inches may be reached 10% of the time.

Water levels below -30 inches would result in a HU value of zero.

References cited:

Tabb, D.C. and N. Kenny, 1969. Contour mapping of the coastal plain of Everglades National Park by the periphyton method. Inst. of Mar. Sci., Univ. of Miami, Coral Gables, Florida, in Tropical Bioindustries, 1990.

HhI x square miles affected = hydrohabitat units (HhU) for an alternative increment. A western and an eastern increment are separable.

CALCULATING HYDROHABITAT INDEXES

Where D = water depth in inches and H = hydrohabitat index:

For wet period:

If $D > 0$ and $<= 21$, $H = 1.0$.
If $D > 21$ and $<= 24$, $H = 7.3 - 0.3D$.
If $D > 24$, $H = 0.1$.

For average period:

If $D >= 8.5$, $H = 1.0$.
If $D > 0$ and < 8.5, $H = 0.1 + 0.106D$.
If $D <= 0$, $H = 0.1$.

For dry period:

If $D >= 0$, $H = 1.0$.
If $D < 0$, $H = 1 + 0.033D$.

FIGURE EIS-G-1
Marl Prairie Model - Hydrohabitat Index vs. Water Depth

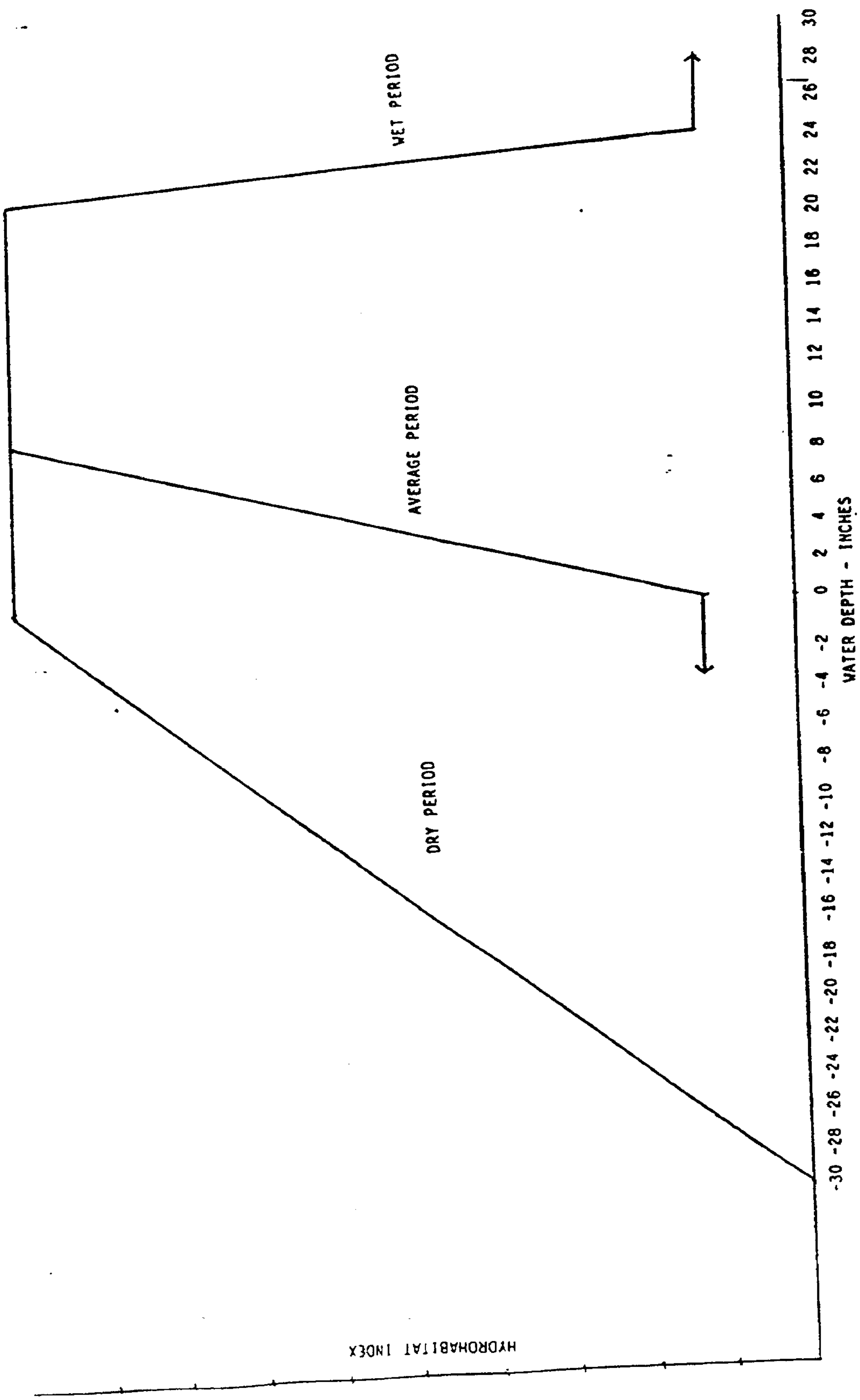

Figure EIS-G-1 Marl Prairie Model - Hydrohabitat Index vs. Water Depth

C-111 Marl Model Data.

ALT 1

	10% EXCEEDANCE						50% EXCEEDANCE						90 % EXCEEDANCE				
	NODE	GRND ELEV	ALT 1	WATER IN FEET	DEPTH-INCHES EAST	DEPTH-INCHES WEST	NODE	ELEV	ALT 1	WATER IN FEET	DEPTH-INCHES WEST	DEPTH-INCHES EAST	NODE	ELEV	ALT 1	WATER IN FEET	DEPTH-INCHES WEST	DEPTH-INCHES EAST
	244.00	1.13	2.11	0.98		11.76	244.00	1.13	1.73	0.60		7.20	244.00	1.13	0.28	-0.85		-10.20
	443.00	1.52	2.45	0.93		11.16	443.00	1.52	1.88	0.36		4.32	443.00	1.52	0.38	-1.14		-13.68
E	453.00	0.20	1.42	1.22	14.64		453.00	0.20	0.92	0.72	8.64		453.00	0.20	-0.55	-0.75	-9.00	
E	455.00	0.05	1.36	1.31	15.72		455.00	0.05	0.86	0.81	9.72		455.00	0.05	-0.51	-0.56	-6.72	
	547.00	1.32	2.24	0.92		11.04	547.00	1.32	1.73	0.41		4.92	547.00	1.32	0.26	-1.06		-12.72
	550.00	1.05	1.79	0.74		8.88	550.00	1.05	1.25	0.20		2.40	550.00	1.05	-0.17	-1.22		-14.64
E	558.00	0.90	1.91	1.01	12.12		558.00	0.90	1.17	0.27	3.24		558.00	0.90	-0.14	-1.04	-12.48	
	751.00	1.85	2.61	0.76		9.12	751.00	1.85	1.88	0.03		0.36	751.00	1.85	0.40	-1.45		-17.40
E	755.00	0.83	2.29	1.46	17.52		755.00	0.83	1.47	0.64	7.68		755.00	0.83	0.08	-0.75	-9.00	
	847.00	1.44	3.13	1.69		20.28	847.00	1.44	2.44	1.00		12.00	847.00	1.44	0.89	-0.55		-6.60
E	853.00	1.63	2.39	0.76	9.12		853.00	1.63	1.68	0.05	0.60		853.00	1.63	0.58	-1.05	-12.60	
E	858.00	1.10	2.00	0.90	10.80		858.00	1.10	1.35	0.25	3.00		858.00	1.10	-0.08	-1.18	-14.16	
	1050.00	3.45	3.23	-0.22		-2.64	1050.00	3.45	2.44	-1.01		-12.12	1050.00	3.45	1.42	-2.03		-24.36
	1147.00	1.95	3.72	1.77		21.24	1147.00	1.95	2.72	0.77		9.24	1147.00	1.95	1.75	-0.20		-2.40
	1153.00	2.19	2.58	0.39		4.68	1153.00	2.19	2.07	-0.12		-1.44	1153.00	2.19	1.02	-1.17		-14.04
	1347.00	3.95	4.83	0.88		10.56	1347.00	3.95	4.19	0.24		2.88	1347.00	3.95	2.44	-1.51		-18.12
	641.00	1.88	2.73	0.85		10.20	641.00	1.88	2.21	0.33		3.96	641.00	1.88	0.61	-1.27		-15.24

WEST BASIN

FOR 10% EXCEEDANCE, MAX DEPT 21.24 INCHES 10HI 0.93

FOR 50% EXCEEDANCE, MIN DEPT -12.12 INCHES 50HI 0.10 WHI= 0.27

FOR 90% EXCEEDANCE, MIN DEPT -24.36 INCHES 90HI 0.20

SQ. MI 895.00 WHU= 242 ALT 1 HU= 294

AVG DEPTHS 13.32 10.57 INCHES AVG DEP 5.48 3.07 INCHES

EAST BASIN

FOR 10% EXCEEDANCE, MAX DEPT 17.52 INCHES 10HI= 1.00

FOR 50% EXCEEDANCE, MIN DEPT 0.60 INCHES 50HI= 0.16 EHI= 0.44

FOR 90% EXCEEDANCE, MIN DEPT -14.16 INCHES 90HI= 0.53

SQ MI= 118.00 EHU= 52

AVG DEP -10.66 -13.58 INCHES

C-111 Marl Model Data.

ALT 2	NODE	10% EXCEEDANCE GRND ELEV	ALT 2	WATER IN FEET	DEPTH-INCHES EAST	WEST
	244.00	1.13	2.13	1.00		12.00
	243.00	1.52	2.47	0.95		11.40
E	253.00	0.20	1.44	1.24	14.88	
E	255.00	0.05	1.37	1.32	15.84	
	547.00	1.32	2.30	0.98		11.76
	550.00	1.05	1.84	0.79		9.48
E	558.00	0.90	1.92	1.02	12.24	
	751.00	1.85	2.68	0.83		9.96
E	755.00	0.83	2.29	1.46	17.52	
	847.00	1.44	3.25	1.81		21.72
E	853.00	1.63	2.39	0.76	9.12	
E	858.00	1.10	2.01	0.91	10.92	
	1050.00	3.45	3.47	0.02		0.24
	1147.00	1.95	3.93	1.98		23.76
	1153.00	2.19	2.59	0.40		4.80
	1327.00	3.95	4.48	0.53		6.36
	641.00	1.88	2.75	0.87		10.44

WEST BASIN
FOR 10% EXCEEDANCE, MAX DEPT 23.76 INCHES 10HI= 0.17
FOR 50% EXCEEDANCE, MIN DEPT -12.36 INCHES 50HI= 0.10
FOR 90% EXCEEDANCE, MIN DEPT -24.48 INCHES 90HI= 0.19
SQ MI = 829.00 WHU= 124
AVG DEPTHS 13.42 11.08 INCHES

NODE	50% EXCEEDANCE ELEV	ALT 2	WATER IN FEET	DEPTH-INCHES EAST	WEST
244.00	1.13	1.76	0.63		7.56
243.00	1.52	1.87	0.35		4.20
253.00	0.20	0.95	0.75	9.00	
255.00	0.05	0.88	0.83	9.96	
547.00	1.32	1.72	0.40		4.80
550.00	1.05	1.25	0.20		2.40
558.00	0.90	1.18	0.28	3.36	
751.00	1.85	1.88	0.03		0.36
755.00	0.83	1.48	0.65	7.80	
847.00	1.44	2.39	0.95		11.40
853.00	1.63	1.69	0.06	0.72	
858.00	1.10	1.35	0.25	3.00	
1050.00	3.45	2.42	-1.03		-12.36
1147.00	1.95	2.67	0.72		8.64
1153.00	2.19	2.09	-0.10		-1.20
1327.00	3.95	3.63	-0.32		-3.84
641.00	1.88	2.20	0.32		3.84

WHI= 0.15
ALT 2 HU= 184
AVG DEP 5.64 2.35 INCHES

NODE	90 % EXCEEDANCE ELEV	ALT 2	WATER IN FEET	DEPTH-INCHES EAST	WEST
244.00	1.13	0.25	-0.88		-10.56
243.00	1.52	0.37	-1.15		-13.80
253.00	0.20	-0.52	-0.72	-8.64	
255.00	0.05	-0.44	-0.49	-5.88	
547.00	1.32	0.23	-1.09		-13.08
550.00	1.05	-0.19	-1.24		-14.88
558.00	0.90	-0.10	-1.00	-12.00	
751.00	1.85	0.44	-1.41		-16.92
755.00	0.83	0.13	-0.70	-8.40	
847.00	1.44	0.84	-0.60		-7.20
853.00	1.63	0.62	-1.01	-12.12	
858.00	1.10	-0.06	-1.16	-13.92	
1050.00	3.45	1.41	-2.04		-24.48
1147.00	1.95	1.64	-0.31		-3.72
1153.00	2.19	1.06	-1.13		-13.56
1327.00	3.95	2.17	-1.78		-21.36
641.00	1.88	0.61	-1.27		-15.24

EAST BASIN
FOR 10% EXCEEDANCE, MAX DEPT 17.52 INCHES 10HI= 1.00
FOR 50% EXCEEDANCE, MIN DEPT 0.72 INCHES 50HI= 0.18 EHI= 0.46
FOR 90% EXCEEDANCE, MIN DEPT -13.92 INCHES 90HI= 0.54
SQ MI= 130.00 EHU= 60
AVG DEP-10.16 -14.07 INCHES

C-111 Marl Model Data.

ALT 3	NODE	10% EXCEEDANCE GRND ELEV	ALT 3	WATER IN FEET	DEPTH-INCHES EAST	WEST	NODE	50% EXCEEDANCE ELEV	ALT 3	WATER IN FEET	DEPTH-INCHES EAST	WEST	NODE	90 % EXCEEDANCE ELEV	ALT 3	WATER IN FEET	DEPTH-INCHES EAST	WEST
	244.00	1.13	2.09	0.96		11.52	244.00	1.13	1.73	0.60		7.20	244.00	1.13	0.25	-0.88		-10.56
	443.00	1.52	2.43	0.91		10.92	443.00	1.52	1.86	0.34		4.08	443.00	1.52	0.36	-1.16		-13.92
E	453.00	0.20	1.49	1.29	15.48		453.00	0.20	0.93	0.73	8.76		453.00	0.20	-0.67	-0.87	-10.44	
E	455.00	0.05	1.37	1.32	15.84		455.00	0.05	0.83	0.78	9.36		455.00	0.05	-0.74	-0.79	-9.48	
	547.00	1.32	2.20	0.88		10.56	547.00	1.32	1.70	0.38		4.56	547.00	1.32	0.23	-1.09		-13.08
	550.00	1.05	1.85	0.80		9.60	550.00	1.05	1.22	0.17		2.04	550.00	1.05	-0.24	-1.29		-15.48
E	558.00	0.90	1.92	1.02	12.24		558.00	0.90	1.12	0.22	2.64		558.00	0.90	-0.42	-1.32	-15.84	
	751.00	1.85	2.47	0.62		7.44	751.00	1.85	1.84	-0.01		-0.12	751.00	1.85	0.19	-1.66		-19.92
E	755.00	0.83	2.12	1.29	15.48		755.00	0.83	1.45	0.62	7.44		755.00	0.83	-0.22	-1.05	-12.60	
	847.00	1.44	3.06	1.62		19.44	847.00	1.44	2.37	0.93		11.16	847.00	1.44	0.79	-0.65		-7.80
E	853.00	1.63	2.38	0.75	9.00		853.00	1.63	1.69	0.06	0.72		853.00	1.63	0.22	-1.41	-16.92	
E	858.00	1.10	2.01	0.91	10.92		858.00	1.10	1.38	0.28	3.36		858.00	1.10	-0.15	-1.25	-15.00	
	1050.00	3.45	3.45	0.00		0.00	1050.00	3.45	2.43	-1.02		-12.24	1050.00	3.45	1.30	-2.15		-25.80
	1147.00	1.95	3.63	1.68		20.16	1147.00	1.95	2.64	0.69		8.28	1147.00	1.95	1.65	-0.30		-3.60
	1153.00	2.19	2.99	0.80		9.60	1153.00	2.19	2.27	0.08		0.96	1153.00	2.19	1.06	-1.13		-13.56
	1347.00	3.95	4.69	0.74		8.88	1347.00	3.95	3.92	-0.03		-0.36	1347.00	3.95	2.25	-1.70		-20.40
	641.00	1.88	2.71	0.83		9.96	641.00	1.88	2.20	0.32		3.84	641.00	1.88	0.61	-1.27		-15.24

WEST BASIN
FOR 10% EXCEEDANCE, MAX DEPT 20.16 INCHES 10HI= 1.00
FOR 50% EXCEEDANCE, MIN DEPT -12.24 INCHES 50HI= 0.10 WHI= 0.25
FOR 90% EXCEEDANCE, MIN DEPT -25.80 INCHES 90HI= 0.15
SQ MI = 917.00 WHU= 229 ALT 3 HU= 284
AVG DEPTHS 13.16 10.73 INCHES AVG DEP 5.38 2.67 INCHES

EAST BASIN
FOR 10% EXCEEDANCE, MAX DEPT 15.84 INCHES 10HI= 1.00
FOR 50% EXCEEDANCE, MIN DEPT 0.72 INCHES 50HI= 0.18 EHI= 0.43
FOR 90% EXCEEDANCE, MIN DEPT -16.92 INCHES 90HI= 0.44
SQ MI= 127.00 EHU= 55
AVG DEP-13.38 -14.49 INCHES

C-111 Marl Model Data.

ALT 4	NODE	10% EXCEEDANCE GRND ELEV	10% EXCEEDANCE ALT 4	WATER IN FEET	DEPTH-INCHES EAST	DEPTH-INCHES WEST
	244.00	1.13	2.11	0.98		11.76
	443.00	1.52	2.45	0.93		11.16
E	453.00	0.20	1.45	1.25	15.00	
E	455.00	0.05	1.34	1.29	15.48	
	547.00	1.32	2.23	0.91		10.92
	550.00	1.05	1.82	0.77		9.24
E	558.00	0.90	1.84	0.94	11.28	
	751.00	1.85	2.48	0.63		7.56
E	755.00	0.83	1.95	1.12	13.44	
	847.00	1.44	3.13	1.69		20.28
E	853.00	1.63	2.20	0.57	6.84	
E	858.00	1.10	1.95	0.85	10.20	
	1050.00	3.45	3.21	-0.24		-2.88
	1147.00	1.95	3.73	1.78		21.36
	1153.00	2.19	2.74	0.55		6.60
	1347.00	3.95	4.54	0.59		7.08
	641.00	1.88	2.73	0.85		10.20

WEST BASIN
FOR 10% EXCEEDANCE, MAX DEPT 21.36 INCHES 10HI= 0.89
FOR 50% EXCEEDANCE, MIN DEPT -12.24 INCHES 50HI= 0.10 WHI= 0.26
FOR 90% EXCEEDANCE, MIN DEPT -24.60 INCHES 90HI= 0.19
SQ MI = 1034.00 WHU= 269 ALT 4 HU= 314
AVG DEPTHS 12.04 10.30 INCHES

NODE	50% EXCEEDANCE ELEV	50% EXCEEDANCE ALT 4	WATER IN FEET	DEPTH-INCHES EAST	DEPTH-INCHES WEST
244.00	1.13	1.73	0.60		7.20
443.00	1.52	1.87	0.35		4.20
453.00	0.20	0.91	0.71	8.52	
455.00	0.05	0.75	0.70	8.40	
547.00	1.32	1.71	0.39		4.68
550.00	1.05	1.24	0.19		2.28
558.00	0.90	1.04	0.14	1.68	
751.00	1.85	1.83	-0.02		-0.24
755.00	0.83	1.37	0.54	6.48	
847.00	1.44	2.40	0.96		11.52
853.00	1.63	1.66	0.03	0.36	
858.00	1.10	1.34	0.24	2.88	
1050.00	3.45	2.43	-1.02		-12.24
1147.00	1.95	2.69	0.74		8.88
1153.00	2.19	2.23	0.04		0.48
1347.00	3.95	3.82	-0.13		-1.56
641.00	1.88	2.20	0.32		3.84

AVG DEP 4.72 2.64 INCHES

NODE	90 % EXCEEDANCE ELEV	90 % EXCEEDANCE ALT 4	WATER IN FEET	DEPTH-INCHES EAST	DEPTH-INCHES WEST
244.00	1.13	0.26	-0.87		-10.44
443.00	1.52	0.39	-1.13		-13.56
453.00	0.20	-0.72	-0.92	-11.04	
455.00	0.05	-0.84	-0.89	-10.68	
547.00	1.32	0.26	-1.06		-12.72
550.00	1.05	-0.23	-1.28		-15.36
558.00	0.90	-0.46	-1.36	-16.32	
751.00	1.85	0.19	-1.66		-19.92
755.00	0.83	-0.30	-1.13	-13.56	
847.00	1.44	0.83	-0.61		-7.32
853.00	1.63	0.18	-1.45	-17.40	
858.00	1.10	-0.22	-1.32	-15.84	
1050.00	3.45	1.40	-2.05		-24.60
1147.00	1.95	1.67	-0.28		-3.36
1153.00	2.19	1.06	-1.13		-13.56
1347.00	3.95	2.11	-1.84		-22.08
641.00	1.88	0.63	-1.25		-15.00

EAST BASIN
FOR 10% EXCEEDANCE, MAX DEPT 15.48 INCHES 10HI= 1.00
FOR 50% EXCEEDANCE, MIN DEPT 0.36 INCHES 50HI= 0.14 EHI= 0.39
FOR 90% EXCEEDANCE, MIN DEPT -17.40 INCHES 90HI= 0.43
SQ MI= 116.00 EHU= 45
AVG DEP-14.14 -14.36 INCHES

C-111 Marl Model Data.

ALT 5	NODE	10% EXCEEDANCE GRND ELEV	10% EXCEEDANCE ALT 5	WATER IN FEET	DEPTH-INCHES EAST	DEPTH-INCHES WEST	NODE	50% EXCEEDANCE ELEV	50% EXCEEDANCE ALT 5	WATER IN FEET	DEPTH-INCHES EAST	DEPTH-INCHES WEST	NODE	90 % EXCEEDANCE ELEV	90 % EXCEEDANCE ALT 5	WATER IN FEET	DEPTH-INCHES EAST	DEPTH-INCHES WEST
	244.00	1.13	2.09	0.96		11.52	244.00	1.13	1.71	0.58		6.96	244.00	1.13	0.24	-0.89		-10.68
	443.00	1.52	2.42	0.90		10.80	443.00	1.52	1.84	0.32		3.84	443.00	1.52	0.36	-1.16		-13.92
E	453.00	0.20	1.45	1.25	15.00		453.00	0.20	0.92	0.72	8.64		453.00	0.20	-0.54	-0.74	-8.88	
E	455.00	0.05	1.39	1.34	16.08		455.00	0.05	0.89	0.84	10.08		455.00	0.05	-0.45	-0.50	-6.00	
	547.00	1.32	2.18	0.86		10.32	547.00	1.32	1.69	0.37		4.44	547.00	1.32	0.21	-1.11		-13.32
	550.00	1.05	1.78	0.73		8.76	550.00	1.05	1.23	0.18		2.16	550.00	1.05	-0.20	-1.25		-15.00
E	558.00	0.90	1.81	0.91	10.92		558.00	0.90	1.07	0.17	2.04		558.00	0.90	-0.18	-1.08	-12.96	
	751.00	1.85	2.49	0.64		7.68	751.00	1.85	1.79	-0.06		-0.72	751.00	1.85	0.47	-1.38		-16.56
E	755.00	0.83	1.95	1.12	13.44		755.00	0.83	1.33	0.50	6.00		755.00	0.83	0.12	-0.71	-8.52	
	847.00	1.44	3.07	1.63		19.56	847.00	1.44	2.36	0.92		11.04	847.00	1.44	0.80	-0.64		-7.68
E	853.00	1.63	2.11	0.48	5.76		853.00	1.63	1.65	0.02	0.24		853.00	1.63	0.70	-0.93	-11.16	
E	858.00	1.10	1.92	0.82	9.84		858.00	1.10	1.31	0.21	2.52		858.00	1.10	-0.12	-1.22	-14.64	
	1050.00	3.45	3.45	0.00		0.00	1050.00	3.45	2.38	-1.07		-12.84	1050.00	3.45	1.35	-2.10		-25.20
	1147.00	1.95	3.65	1.70		20.40	1147.00	1.95	2.61	0.66		7.92	1147.00	1.95	1.58	-0.37		-4.44
	1153.00	2.19	2.63	0.44		5.28	1153.00	2.19	2.10	-0.09		-1.08	1153.00	2.19	1.06	-1.13		-13.56
	1347.00	3.95	4.46	0.51		6.12	1347.00	3.95	3.81	-0.14		-1.68	1347.00	3.95	2.11	-1.84		-22.08
	641.00	1.88	2.69	0.81		9.72	641.00	1.88	2.19	0.31		3.72	641.00	1.88	0.60	-1.28		-15.36

WEST BASIN
FOR 10% EXCEEDANCE, MAX DEPT 20.40 INCHES 10HI= 1.00
FOR 50% EXCEEDANCE, MIN DEPT -12.84 INCHES 50HI= 0.10 WHI= 0.26
FOR 90% EXCEEDANCE, MIN DEPT -25.20 INCHES 90HI= 0.17
SQ MI = 938.00 WHU= 244 ALT 5 HU= 294
AVG DEPTHS 11.84 10.01 INCHES AVG DEP 4.92 2.16 INCHES

EAST BASIN
FOR 10% EXCEEDANCE, MAX DEPT 16.08 INCHES 10HI= 1.00
FOR 50% EXCEEDANCE, MIN DEPT 0.24 INCHES 50HI= 0.13 EHI= 0.41
FOR 90% EXCEEDANCE, MIN DEPT -14.64 INCHES 90HI= 0.52
SQ MI= 123.00 EHU= 50
AVG DEP-10.36 -14.35 INCHES

C-111 Marl Model Data.

ALT6/6A	NODE	10% EXCEEDANCE GRND ELEV	ALT6/6A	WATER IN FEET	DEPTH-INCHES EAST	DEPTH-INCHES WEST
	244.00	1.13	2.10	0.97		11.64
	243.00	1.52	2.45	0.93		11.16
E	453.00	0.20	1.41	1.21	14.52	
E	455.00	0.05	1.35	1.30	15.60	
	547.00	1.32	2.22	0.90		10.80
	550.00	1.05	1.78	0.73		8.76
E	558.00	0.90	1.90	1.00	12.00	
	751.00	0.85	1.61	0.76		9.12
E	755.00	0.83	2.27	1.44	17.28	
	847.00	1.44	3.13	1.69		20.28
E	853.00	1.63	2.37	0.74	8.88	
E	858.00	1.10	2.00	0.90	10.80	
	1050.00	3.45	3.22	-0.23		-2.76
	1147.00	1.95	3.72	1.77		21.24
	1153.00	2.19	2.57	0.38		4.56
	1347.00	3.95	4.55	0.60		7.20
	641.00	1.88	2.73	0.85		10.20

WEST BASIN

FOR 10% EXCEEDANCE, MAX DEPT 21.24 INCHES 10HI= 0.93
FOR 50% EXCEEDANCE, MIN DEPT -12.36 INCHES 50HI= 0.10 WHI= 0.27
FOR 90% EXCEEDANCE, MIN DEPT -24.12 INCHES 90HI= 0.20
SQ MI= 1027.00 WHU= 277 AVG DEPTHS 13.18 10.20 INCHES

NODE	50% EXCEEDANCE ELEV	ALT6/6A	WATER IN FEET	DEPTH-INCHES EAST	DEPTH-INCHES WEST
244.00	1.13	1.73	0.60		7.20
243.00	1.52	1.87	0.35		4.20
453.00	0.20	0.90	0.70	8.40	
455.00	0.05	0.85	0.80	9.60	
547.00	1.32	1.71	0.39		4.68
550.00	1.05	1.24	0.19		2.28
558.00	0.90	1.15	0.25	3.00	
751.00	0.85	1.86	1.01		0.12
755.00	0.83	1.46	0.63	7.56	
847.00	1.44	2.40	0.96		11.52
853.00	1.63	1.67	0.04	0.48	
858.00	1.10	1.34	0.24	2.88	
1050.00	3.45	2.42	-1.03		-12.36
1147.00	1.95	2.68	0.73		8.76
1153.00	2.19	2.07	-0.12		-1.44
1347.00	3.95	3.77	-0.18		-2.16
641.00	1.88	2.20	0.32		3.84

ALT6/6A HU= 332 AVG DEP 5.32 2.42 INCHES

NODE	90 % EXCEEDANCE ELEV	ALT6/6A	WATER IN FEET	DEPTH-INCHES EAST	DEPTH-INCHES WEST
244.00	1.13	0.27	-0.86		-10.32
243.00	1.52	0.39	-1.13		-13.56
453.00	0.20	-0.50	-0.70	-8.40	
455.00	0.05	-0.41	-0.46	-5.52	
547.00	1.32	0.27	-1.05		-12.60
550.00	1.05	-0.17	-1.22		-14.64
558.00	0.90	-0.05	-0.95	-11.40	
751.00	0.85	0.52	-1.33		-15.96
755.00	0.83	0.17	-0.66	-7.92	
847.00	1.44	0.85	-0.59		-7.08
853.00	1.63	0.69	-0.94	-11.28	
858.00	1.10	-0.09	-1.19	-14.28	
1050.00	3.45	1.44	-2.01		-24.12
1147.00	1.95	1.66	-0.29		-3.48
1153.00	2.19	1.07	-1.12		-13.44
1347.00	3.95	2.11	-1.84		-22.08
641.00	1.88	0.62	-1.26		-15.12

EAST BASIN

FOR 10% EXCEEDANCE, MAX DEPT 17.28 INCHES 10HI= 1.00
FOR 50% EXCEEDANCE, MIN DEPT 0.48 INCHES 50HI= 0.15 EHI= 0.43
FOR 90% EXCEEDANCE MIN DEPT -14.28 INCHES 90HI= 0.53
SQ MI= 128.00 EHU= 55 AVG DEP -9.80 -13.85 INCHES

ANNEX H

CONCEPT OF ENVIRONMENTAL MONITORING
CENTRAL AND SOUTHERN FLORIDA PROJECT

C-111

CONCEPT OF ENVIRONMENTAL MONITORING CENTRAL AND SOUTHERN FLORIDA PROJECT

C-111

The foundation for project monitoring was laid in 1992 as part of environmental planning. A cooperative effort between the ENP, the USFWS, and the USACE produced a plan of studies for projecting the impacts of C-111 alternative plans. The plan of studies called for comparison of the projected impacts of considered alternatives in relation to historical (natural) and existing (base) hydrological conditions. Impacts on the principal vegetative communities are assessed using a "natural systems" hydrological model that is validated with soils and historical water stage information. Species and natural community responses to historical, base, and alternative hydrological conditions are assessed with input from acknowledged experts.

Study protocols will be refined during the detailed design phase to produce a detailed ecological monitoring plan. The plan will be an interagency product, involving Department of the Interior agencies, the National Oceanic and Atmospheric Administration (NOAA), the State of Florida, the U.S. Army Corps of Engineers, and the South Florida Water Management District. Opinions of experts on various ecosystem components (species, plant and animal ecology) will be sought. The monitoring plan will be implemented, beginning in the detailed design phase and continued through construction. It is expected that the monitoring program will be continued after construction and during project operations under the leadership of ENP and/or SFWMD. A conceptual outline of the management plan appears below.

A CONCEPTUAL MONITORING PLAN OUTLINE C-111--TAYLOR SLOUGH PROJECT

Assumption: The C-111--Taylor Slough area will be a managed system, with water supplied in quantities, frequencies, and durations to be agreed upon by the appropriate agencies in compliance with existing laws and directives and in consideration of all affected parties.

Project Goal: The project goals are: (a) restoration of the historical hydropatterns of the Taylor Slough, C-111 basin, eastern Florida Bay and Barnes Sound estuaries, functioning in response to the adjacent, upstream, long-hydroperiod, Shark Slough system; and (b) selection of a modified system based on a water supply regime necessitated by consideration of requirements of the greater, Central and Southern Florida Project for Flood Control and Other Purposes. The C&SF Project is under restudy, and the results and recommendations from that study are expected to affect the C-111--Taylor Slough system.

Study Objectives: Detect ecological and hydrological responses to actual project operations including establishment of pre-operations baselines. Enable measurement of attainment of Project Goal. Permit formulation of remedial measures as necessary.

Study Team: Representatives of the Department of the Interior agencies, the National Oceanic and Atmospheric Administration (NOAA), the State of Florida, the U.S. Army Corps of Engineers, the South Florida Water Management District and other interested agencies.

Period of Study: Upon approval of this GRR-EIS and until the end of the construction period, or 8 years.

Cost: Estimated cost for monitoring is $8,000,000.

Data Storage and Retrieval: Data will be stored and retrieved with an HEC-DSS or similar data retrieval system and displayed by means of a Geographic Information System.

Study Elements:

STUDY AREA - Taylor Slough and headwaters to (include) Shark Slough
Coastal sloughs, mangroves
Barnes Sound, Manatee Bay
Florida Bay nearshore (define) between Highway 1 and Central Florida Bay
Affected area west of C-111 and L-31N

WATER

Supply - Annual hydroperiods, depths, timing, interannual hydropatterns
Quality - nutrients, salinity, pesticides

SYSTEM LINKAGE

Shark River Slough, Florida Bay, Water Conservation Areas

SPECIES/COMMUNITIES

Plant communities; indigenous dominant, native and exotic invaders, periphyton. Sampling regimen will reveal trends in species dominance and productivity in response to project operation hydrology.

Invertebrates; crustaceans (macro-, micro-), insects (forage, pollinators, weed control), other (annelids). Sampling will be designed to reveal responses to project operation hydrology of organisms that function as fish-food, pollinators, and plant control .

Fishes. Species and productivity responses to hydrology.

Amphibians/Reptiles. Species that are significant biomass producers used as food by wading birds will be sampled to reveal biomass response to hydrology. American alligator function and significance as habitat modifier will be assessed in relation to hydrology.

Wading Bird Species or Guilds. Sampling will indicate reproductive success in relation to project-induced hydrology. Some species may be grouped in guilds.

Endangered or threatened (include prey). Impact of project-induced hydrology on listed species will be assessed. (Wood Stork, Snail Kite, Cape Sable Sparrow, American Crocodile, etc.) American crocodile reproductive success in relation to hydrology.

Procedures: Monitoring station establishment will accommodate standard methods of sampling and statistical analysis. Insofar as the aforestated criterion will permit, stations for each study element will be located in proximity to stations for other elements, with separations to ensure no disturbance from other element sampling. Sampling station locations will be recorded in a Geographical Information System (GIS), as will sampling data from each study element. Sampling will represent each identified sub-area in the study area. Data will be transformed into information that can be entered in the GIS, permitting retrieval and comparison of study element information, e.g., biological responses to hydrology; predator response to food patchiness or concentration; comparison among food chain echelons. Wildlife and Plant community monitoring protocols will be developed by interagency teams.

ANNEX I

C-111

C-111 DRAFT REPORT RECIPIENTS

LIST OF ADDRESSEES

C-111
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CENTRAL AND SOUTHERN FLORIDA PROJECT
FOR FLOOD CONTROL AND OTHER PURPOSES

CANAL 111 (C-111)
SOUTH DADE COUNTY

APPENDICES TO THE
FINAL INTEGRATED GENERAL REEVALUATION REPORT
AND ENVIRONMENTAL IMPACT REPORT

List of Appendices

C-111
GENERAL REEVALUATION REPORT
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Appendix A
Hydrology and Hydraulic Analysis

1. General. This appendix addresses the hydrologic modeling and hydraulic design efforts for providing a more natural distribution of runoff into Everglades National Park while providing 40% SPF protection for the C-111 upper watershed. For the environmental impact analysis the model simulated daily runoff for the 25-year period 1965-1989. For flood damage analysis, a 20-day storm event for the 2-, 10-, 50-year, and Standard Project Flood was applied on a selected month to establish the flood damages that could be expected from maintaining water levels at authorized levels.

2. Basin Description. The L-31N/C-111 canal system drains an area of 97.3 square miles. This canal system also drains an area of 12.67 square miles through pump station S-331 whenever water levels at the downstream structures are below design stages. The combined drainage area is bounded by Tamiami Trail on the north, L-31N and L-31W levees and Everglades National Park on the west, C-111 canal on the south, and State Road 27 and U.S. Highway 1 on the east. Structures S-331, S-338, S-194 and S-196 are closed during floods and act as northern and eastern boundaries to surface flow.

3. Soils. There are four major soil groups in the study area: Marl, Rockdale, Rockland and organic. The soils in the basin have a slow infiltration rate when thoroughly wetted. However, they form only a discontinuous, relatively thin layer, over the very porous limestone rock of the Biscayne Aquifer.

4. Modeling. Previous hydraulic models of lower L-31 and C-111 include HEC-2 backwater models for channel sections and overland areas below the gaps in C-111. In 1988, a channel operation model, CHANOP, was built to include the reaches between S-197 and S-331. CHANOP is a one-dimensional unsteady flow model that simulates channel flow, structure operations, and overland flow. Groundwater is accounted for only in the loss rates included in the hydrologic analysis. A comparison of flood stages produced by CHANOP and the 1x1 South Florida Water Management model produced similar results near the existing channel alignment. Flood stages and recession rates inland did not compare well between the models. Both models budget total water volume. However, CHANOP deals only with surface runoff, and assumes that available ground storage has been satisfied, while the 1x1 SFWMM utilizes groundwater storage along with the aquifer's capacity to act as a flow medium.

The movement of water in Dade County is influenced not only by the manmade canals, structures and levees, but also by the flat terrain and the highly porous limestone aquifer. Under contract with the Jacksonville District the South Florida Water Management District has developed a digital surface-ground water model covering Dade, Broward, and Palm Beach Counties. Big Cypress Swamp in Collier County is now included, also. The model uses a square grid network to model two-dimensional movement of water. A two-by-two (2x2) mile node spacing is used. Surface (overland) flow modeling adds rainfall and surface inflow to beginning storage then subtracts evapotranspiration, infiltration, and surface outflow. One day time steps are used. Evapotranspiration varies with depth of water table below the land surface. Overland flow is computed using Manning's equation with Manning's "n" varying with depth of flow. Infiltration is either at the maximum rate read in at each grid point or the amount available in groundwater storage. Channel flow is calculated by reading in upstream inflow while downstream outflows and seepage are calculated by an iterative process. Outflow is estimated using actual discharge rating characteristics or a simplified weir equation and the head difference at the structure. Operation of the significant water control structures is simulated in the ROUTE subroutine. Groundwater flow is calculated using a two-dimensional flow equation for a porous aquifer. Subroutines are provided in the model to simulate hydrologic responses in the Everglades Agricultural Area and Lake Okeechobee. A detailed documentation of the model is contained in SFWMD's Technical Publication 84-3. A higher definition version of the 2x2 model exists for the area south of Tamiami Canal. This version has 1 square-mile grids (1x1) instead of 4 square-mile grids (2x2). The denser grid network presents a more accurate picture of water levels. Using the 2x2 model to provide boundary conditions, the 1x1 model was used to analyze the base and alternative plans. The denser 1x1 mile grid network better defines water levels in the East Everglades area. Because the 1x1 model does not include the northern two-thirds of the lower east coast drainage basin, it must be assigned the flow or stages for each day for the period 1965-89 along its northern boundary. Daily discharges at S-334 and S-335 are input to the 1x1 model in a file designated FLO2x2. Daily stages are given by the 2x2 file KNSTGS at 35 grid cells along the northern boundary. These cells in turn are interpolated to obtain the stages for the 71 one-square-mile grid cells making up the northern boundary of the 1x1 model. Discharges are not assigned to the S-12 structures because flow is determined from stages developed along the northern boundary by the 2x2 model and the overland flow is computed from these stages.

5. Calibration. The model was calibrated using the period 1969 to 1975. This period was used because it contained both an extremely wet year, 1969, and an extremely dry year, 1971. All measured flows and rainfall were used as inputs to the model and factors such as potential evapotranspiration rate, Manning's overland flow coefficient, and the coefficient of conductivity between canals and the aquifer were adjusted until the stages predicted by the model were in satisfactory agreement with those actually recorded at key locations throughout the area. The calibration is described in the documentation report referenced above. A base condition for the evaluation of alternatives was defined by adding the South Dade Conveyance System, which was not operable during the calibration period. The results of this run became the baseline for comparison with all other model scenarios. The base condition is the current best estimate of the physical and operational water management system. Alternatives for redistributing flow to the Everglades were simulated for the 1965-89 period.

6. Rainfall Frequency. A frequency analysis was performed of peak annual rainfall in the project area for durations of one through 20 days. A log-Pearson Type III distribution was utilized to compute rainfall frequencies. Procedures prescribed in "Guidelines for

Determining Flood Flow Frequency", Bulletin No. 17B of the Hydrology Committee, United States Water Resources Council, Revised September 1981, were used in this analysis.

7. Data. The Homestead Experiment Station is the only long-term record rain gage in the project area. The same rainfall data developed in the survey report based on 1914-1977 rainfall records was used in this analysis. Periods of missing record were checked to determine if a large storm event caused a gage failure. No such cases were identified. Therefore, years with significant cumulative rainfall totals in each year for periods of from one to 20 consecutive days were used for the annual rainfall analysis.

8. Skew Factors. A regional skew analysis was conducted for south Florida. The results of the analysis were used to select skew factors for the rain gages. It was found that skew factors approach zero as the duration increases. The skew factors used at the gage for each duration are shown below.

SKEW FACTORS FOR RAINFALL ANALYSIS

Gage	Duration (days)					
	1	2	5	10	20	>30
Homestead	.3	.1	.1	.1	.1	0

9. Rainfall Frequencies. The point rainfall depth-duration-frequency curves for expected probability for Homestead Experiment Station are presented in Figure A-1.

10. Design Storms. Point rainfall was reduced using the depth area reduction curves in National Weather Service publication "A Methodology for Point-to-Area Rainfall Frequency Ratios," dated February 1980. The 1x1 model accepts daily rainfall input to 13 rain gages, each with its respective area of influence. The areas assigned to the rain gages vary from 26 to 536 square miles. An elliptically shaped storm similar to that often used for the Standard Project Storm was used to help rank the gages in the order of expected rainfall depth. The ellipse was centered between S-176 and S-196 and aligned in a north-northeasterly direction. The respective areas assigned to each rain gage were cumulatively totaled. An appropriate percent of point rainfall was assigned each rain gage such that the total average percent of 24-hour point rainfall agreed with the depth-area curve. The depth-area relationship for a 30-day rainfall was obtained from Table 5, Part VI, Sect. 6 of the C&SF Project GDM. This was used to interpolate an appropriate percent of point rainfall for durations of 2 to 20 days. The rainfall pattern chosen centers the storm about the eleventh day with the next heaviest daily rainfall occurring on the tenth day, the third heaviest rainfall on the twelfth day, etc. Table A-1 shows the percent of point rainfall assigned each rainfall gage number. The 2-year, 10-year and 50-year, 100-year design storm rainfall at each gage are listed in

Table A-2 and Table A-3 respectively. Not shown is the Standard Project Storm which traditionally has been taken to be 125 percent of the 100-year storm on all C&SF structures.

11. Antecedent Moisture Condition. A suitable month had to be selected to apply the four different storm events. Since the design water level for L-31 North borrow canal between S-176 and S-331 is 5.5 feet, NGVD, a stable period with water levels around that level was selected. July 1969 was the most suited to begin the 20-day rainfall.

12. Seasonal Flood Occurrence. Table A-4 shows the number of 1-day and 5-day storm events exceeding a range of rainfall totals for each month of the year for the 1914-1977 period of record. For evaluating agricultural damages, the percent chance of a storm occurring in any given month during the growing season must be known. Since maximum stage occurs a few days after peak rainfall in the most vulnerable of the agricultural areas, the 5-day total rainfall was selected for establishing the seasonal occurrence of the storm events. The 2-year 5-day rainfall total of 7.2 inches was used to represent the beginning of damaging floods. A total of 41 storms equal to or exceeding 7-inches occurred. This is sufficient to get a fair distribution of damaging flood events without including smaller non-damaging storm events that fall outside the flood season. The distribution is presented below. Although the worst storm events all occurred in May, June, September and October, the same percent chance of occurrence was used for the more infrequent flood events as for the 2-year storm.

Percent Occurrence of 5-day Event Storms Exceeding 7.00-inches

Month	Apr	May	Jun	Jul	Aug	Sep	Oct
% Chance	4.9	31.7	19.5	2.5	2.4	26.8	12.2

13. General. Originally, plans called for modeling the environmental impacts using the SFWMM 1x1 version for the 1965-1989 period of record. Flood damage assessment and design were to be based on a runoff model and a dynamic flood routing model using a much shorter computation time interval. The study time frame was shortened, consequently the SFWMM 1x1 was also used for flood damage assessment.

14. Structure Operating Levels. Table A-5 presents the design structure operation water levels and the water levels used in the model. Please note that data for alternative 6A, the recommended plan, is the same as for alternative 6, shown in table A-5.

15. Base Condition. A base condition was established to which all the alternatives could be compared. Base condition was taken to be all the authorized structures, levees, and canals as they presently exist, along with the Modified Water Deliveries to Everglades National Park, which has been authorized by Congress but not yet constructed. This includes the optimum water levels to be maintained upstream of all structures as specified in the authorizing

documents. No optimum was specified for the dry season when it is not feasible to maintain the authorized optimum water levels, so the existing policy practiced by water managers was followed.

16. Alternative Plans. Alternative plans are described in detail in the main report. Model changes were incorporated to reflect structural improvements unique to each plan and operational levels are described in paragraph 14. Boundary conditions, rainfall and evaporation remained constant for all alternatives. Alternative plans are described briefly as:

ALT 1 - S-332 improved to 1000 cfs, S-174 improved to 1500 cfs,lower C-111 remains as is, two 50 cfs pumps provide rehydration to Context Road and the C-109/C-110 area.

ALT 1A - same as ALT 1 except that the 50 cfs pump and canal at the C-109/C-110 area is deleted.

ALT 2 - 1000 cfs pump added at S-174 and lower L-31W backfilled, two 50 cfs pumps provide rehydration to Context Road and the C-109/C-110 area.

ALT 3 - 1630 cfs pump added at S-174, Frog Pond converted to surge pool, 500 cfs pump added to the C-109/C-110 area, lower C-111 backfilled to S-197.

ALT 4 - Four 300 cfs pumps west of L-31N, L-31W backfilled, 500 cfs pump added to the C-109/C-110 area, lower C-111 backfilled to S-197.

ALT 5 - 1000 cfs pump added at S-174 and lower L-31W partially backfilled, 500 cfs pump added to the C-109/C-110 area, lower C-111 partially backfilled to S-197.

ALT 6 - Four 300 cfs pumps west of L-31N, L-31W backfilled, 50 cfs pump added to the C-109/C-110 area.

ALT 6A - Four 300 cfs pumps along L-31N, L-31W backfilled, 50 cfs pump added to the C-109/C-110 area.

The structural improvements associated with each alternative are presented on Plates A-1 through A-8.

17. Model Results.

a. General. Figure A-2 shows a location grid for the 1x1 model and can be used to locate cells referenced in this report. Table A-6 presents the flood durations for each alternative at 54 selected cells, based on the 25 year (1965-1989) period of record simulations. Please note that data for alternative 6A, the recommended plan, is the same as for alternative 6, shown in table A-6. The cells are evenly distributed for environmental impact analysis to include the affected areas within Everglades National Park, as well as the basin reaches east of L-31N and C-111. Table A-7 presents flood event peak stages based on the 20 day rainfall simulations for the 2-year, 10-year, 50-year and SPF storms. Please note that data for alternative 6A, the recommended plan, is the same as for alternative 6, shown in table A-7. The peak stages are provided for flood damage assessment for key cells east of L-31N and C-111. Figure A-3 shows time series hydrographs for key cells east and west of L-31N and C-111. The hydrographs compare the 10-year storm peak stages for the Base condition and the six alternatives.

b. Operational Plan. All alternatives were operated under the same optimum canal stages and design water levels. Optimum and design water levels in the project canals were established on the basis of desirable water control conditions in each area, i.e., optimum groundwater levels, intake and/or discharge structure elevations and removal rates for flood control. Water availability was limited to basin rainfall, existing S-331 water supply releases and seepage inflows form Shark River Slough restoration of Modified Deliveries to Everglades National Park. Lack of available water severely limited the alternatives from reaching their full restoration capabilities; however, each alternative was evaluated under the same conditions and their performance was evaluated relative to each other.

c. Sensitivity Analyses. To test the sensitivity of the area with the recommended plan, two model runs for the 10 year rainfall event were made with pump capacities larger and smaller than those in the recommended plan. These two runs were then compared to results shown by the recommended plan. The first run increased the total pump capacities from 1200 cfs to 2000 cfs (four 500 cfs pump stations were used to deliver water to ENP). The second run decreased the total pump capacities from 1200 cfs to 800 cfs (four 200 cfs pump stations were used to deliver water to ENP). All the pump stations were located in the L-31N canal and were modeled in the same location for the sensitivity analysis.

Stage hydrographs were plotted for the recommended plan and the other two variations of this plan for several grid cells throughout the area. These are shown in figure A-4. Some of those grid cells are located between the two middle pump stations (S-332B & C) and to east of this area.

Review of the model output indicated two main conclusions. First, stages in the area in question are not sensitive to changes in total pump capacity. There were less than 0.2 feet stage differential between the high pump capacity (2000 cfs) and the low pump capacity (800 cfs). Stage differences between the high pump capacity plan and the recommended plan was found to be less than 0.12 feet. These stages were found in grid cells next to the L-31N canal and as far as two miles east of the canal. When the analysis was extended to three miles east of the canal stage differentials fell to less than 0.05 feet. These results are indicative of the high horizontal transmissivities and the lack of secondary drainage.

Second, as expected flood durations are shortened by as much as three days at a stage of 7.00 feet, NGVD, with higher total pumping capacity for cells next to the canal and up to two miles east. Durations are less than one day for areas three miles east of the L-31N canal.

d. Structure 197 (S-197). Figure A-5 shows flows through Structure 197. Flow releases decreased by about 39 percent with the proposed plan. Further reductions are likely through changes in operation for this structure. Increasing the stage at which S-197 discharges flood waters would result in reductions in volume releases. Volumes not released by S-197 would increase sheet flows south of the lower C-111 canal thus bringing greater environmental benefits for this area.

e. Operational Plan-Studies. A proposed buffer zone would separate the agricultural lands to the east of the existing L-31N from the proposed retention/detention zone to the west of the proposed S-332D Tieback. Groundwater seepage studies will enable optimal sighting of the proposed S-332D Tieback levee at the western edge of the buffer zone. This will be critical to the performance of the selected plan, both for environmentally important backseepage and storage of detention flows, but also in selecting optimal canal stages. Rainfall delivery schedules will enable discharges to be timed and hydrograph volumes computed based on measured rainfall. This will allow the hydroperiods in Taylor Slough to best represent restored conditions, not only in water plentiful times, but also during periods of minimal water availability. Regional studies are also underway which will examine water allocations to users, the means of capturing flows that are being lost from the system from coastal canals, and reuse of agricultural runoff. These efforts will lead to a larger available water supply and improved performance of the restored Taylor Slough.

18. Plan For Water Control, ENP-South Dade Conveyance System.

a. South Dade County. The purposes of the project works in South Dade County are to remove the 40-percent standard project flood runoff from the effective drainage area, to reduce depth and duration of larger floods; provide water control to prevent overdrainage in the area; prevent saltwater intrusion; and provide facilities to convey up to 500 cfs to Everglades National Park when normal runoff is available. The ENP-South Dade Conveyance System modified the existing project works in South Dade County.

b. Water Supply. The ENP-South Dade Conveyance System was authorized for the purpose of improving the supply and distribution of water supplies to Everglades National Park, and for expanding agricultural and urban needs. Before supplemental water is introduced into the system from Water Conservation Area No. 3, canal stages are permitted to recede approximately 1.5 feet below the design optimums. The design optimums were established as shown in Table A-8. The above does not include the upstream reaches of the coastal salinity control structures where the design optimum will be maintained.

19. Overall Plan For Water Control - Everglades National Park.

a. Authorization History. In House Document 90-369 preservation of Everglades National Park was recognized as a project purpose and that available water should be provided on an equitable basis with other users. A minimum water supply to Everglades National Park (ENP) from the C&SF Project was guaranteed in June 1970 by PL 91-282. This law stipulated that a annual minimum of 315,000 acre-feet would be distributed to the Park on a monthly basis. This included 270,000 acre-feet to Shark River Slough via the S-12's, 37,000 acre-feet to Taylor Slough at S-332, and 18,000 acre-feet to the Eastern Panhandle at S-18C. Senate Document 91-895, which accompanied the law, provided a formula for deciding when the 16.5 percent quantity applied. The formula was found to be faulty and hasn't been applied since the earliest months of the application of this Act. PL 91-282 did not specify the origin but guaranteed the quantity to be delivered to the Park. Prior to this time deliveries originated from Lake Okeechobee. Consequently, discharges from WCA No. 3A to ENP are allocated from water stored in WCA No. 3A, except when supplemental water is required from other areas (such as Lake Okeechobee). Transfers from WCA No. 3A will be made whenever local runoff is insufficient to meet the minimum monthly release criteria at S-332 and S-18C.

PL 99-190, and subsequent acts, have authorized the Corps of Engineers to modify the schedule of water deliveries to ENP and to conduct the Experimental Program of Water Deliveries to Everglades National Park. The Experimental Program has consisted of a series of iterative field tests for the purpose of collecting hydrologic and biologic data with the ultimate goal being the development of an optimum water delivery plan for ENP. A General Design Memorandum (GDM) for Modified Water Deliveries to Everglades National Park developed a plan for improved water deliveries to the park in conjunction with the Experimental Program of Modified Water Deliveries. The Experimental Program is providing a degree of immediate improvement in water deliveries and is also allowing collection of hydrological and ecological data. This data will be used to identify correlations between water management and the ecological well-being of Everglades National Park.

The ENP-South Dade County Conveyance System was authorized by PL 90-483, 90th Congress, 2d Session, Flood Control Act of 1968. The Conveyance System was authorized for the purpose of conservation and conveyance of water supplies to ENP, and for expanding agricultural and urban needs. As a part of the Conveyance System necessary modifications to the C&SF Project were constructed upstream of L-31W (including improvement of the L-31N Borrow Canal upstream of its confluence with C-103) to enable adequate delivery of water to Taylor Slough and the Park's Eastern Panhandle. No canal improvements were made to L-31W or C-111 as a part of the conveyance system. However, S-332 was added as a part of the system to pump water deliveries to Taylor Slough from L-31W borrow canal. S-332 is operated to satisfy the minimum delivery requirements of Taylor Slough as specified in PL 91-282. In 1976, the specific operation of S-332 was agreed upon in an Agreement and Permit signed by the U.S. Army Corps of Engineers, National Park Service and the C&SF Flood Control District. Although the total annual volume of 37,000 acre-feet to be delivered to Taylor Slough remained the same, the monthly distribution used in the agreement varied slightly from that prescribed in PL 91-282. The average monthly flows in cubic feet per second shown in Table A-9 are the minimum pumping rates governing the operation of Pumping Station 332 and are subject to the availability of water in the system. During flood periods such rates may be exceeded, up to the capacity of the pumping station, upon mutual agreement of the National Park Service, the SFWMD, and the Corps of Engineers. Construction of S-332 was completed in 1980.

The original operational plan for L-31W called for leaving S-175 and S-176 closed during normal wet seasons to provide sufficient head for the discharge of water from L-31W into Taylor Slough. Provided that L-31N borrow canal could be maintained at 6.5 ft., NGVD under these conditions, 500 cfs capacity could be discharged from L-31W to the slough. However, under flood conditions when S-176 would be open, L-31N would be drawn down to elevation 6.0 ft., NGVD. Since 500 cfs of flood flows were to be discharged via L-31W and since stages in the L-31W borrow canal would be about 5.2 ft., NGVD - at which stage only limited flows would pass to the slough - S-175 would be the major outlet for design flood flows. Consequently, S-175 is designed for 500 cfs capacity.

The area between L-31W and C-111 also known as the "Frog Pond" was considered to be included in the C-111 basin. Therefore, secondary drainage of this area (when constructed) would discharge into C-111, not the L-31W borrow canal. At this time only limited secondary drainage works have been constructed.

The Frog Pond consists of 5,000 acres located between L-31W and C-111. A portion of the area, lying along the eastern edge adjacent to C-111 has been used for agriculture since the 1920's. Prior to 1981, there were no water management actions taken to benefit agriculture in the Frog Pond. In 1981, following severe flooding associated with Tropical Storm Dennis, the SFWMD, ENP, and the farmers developed operating criteria that constituted the basis for water management in 1982 and 1983. These criteria called for maintaining a wet season stage of 4.5 ft., NGVD upstream of S-175 and S-177. During the dry season, supplemental water deliveries would be made as necessary to maintain these stages at 3.0 ft., NGVD, if sufficient water was available. There were no intentional lowering of canal stages for the benefit of agriculture. The criteria stated that after stages had receded naturally and tomatoes were planted, S-175 and S-177 discharges would be made following large rainfall events to alleviate flooding.

In 1984, farmers stated that market conditions required earlier land preparation and planting in the Frog Pond. After a series of coordination meetings between the ENP and the farmers, an agreement was reached to conduct a one-year test to evaluate the impacts of the Frog Pond drawdown on Taylor Slough. The operating criteria used during the test was honored by the SFWMD. The criteria called for L-31W and S-177 headwater stages to be lowered to 3.5 ft., NGVD by October 15. This stage was to be maintained in L-31W throughout the growing season. After the tomatoes were planted, the S-177 headwater was to be maintained at 3.7 ft., NGVD until crops were harvested. The Frog Pond drawdowns were conducted in 1984, and continued in 1985, and 1986.

During this same time, the Rain-Driven Water Deliveries to ENP test was being conducted. The congressionally mandated Experimental Water Delivery Program to Everglades National Park (Public Law 98-181, Section 1302), passed by Congress in December 1983, authorized the Corps of Engineers, with the concurrence of the National Park Service and the South Florida Water Management District (SFWMD) to conduct an experimental program of water deliveries from the Central and Southern Florida (C&SF) project. The Act further authorized the Secretary of the Army to acquire interest in lands currently in agricultural production and to construct necessary flood protection measures for homes impacted by any modification of the water delivery schedule to the Park. In the Conference Report (98-551) Congress stated that the change in water delivery could have an adverse impact on privately owned lands east of the Park and recognized the need to address and resolve this situation and treat fairly private land owners whose properties may be affected as a result of water delivery modifications necessary to protect ENP.

On July 12, 1985 an agreement was reached between the SFWMD and the Frog Pond farmers in response to the Kendall et. al. v. Marsh, et. al lawsuit. This agreement permitted the Water Delivery Experiment program to continue without further litigation by the farmers in exchange for lower canal levels during the growing season. In 1985 the Corps of Engineers performed an Environmental Assessment and filed a Finding Of No Significant Impact (FONSI) dated June 7, 1985 for the Experimental Program. On July 24, 1985 a Letter of Agreement between the Corps of Engineers, Everglades National Park (ENP), and SFWMD for the testing process was signed. To date there have been 6 Addenda to the original Letter of Agreement. Addendum 1 presented the operational procedures used in a 2-year test of the Rain-Driven plan for Water Deliveries to the ENP that ended on June 14, 1987. Addendum 2 prescribed operational procedures for the Rain-Driven Plan used through July 10, 1988. Addenda 3,4, and 5 represent continuation of the operational procedures contained in Addendum 2. Section 107 of Public Law 102-104 authorized continuation of the Experimental Program of Water Deliveries to ENP until the modifications to the C&SF Project authorized under Section 104 of Public Law 102-229 are completed and implemented.

b. Taylor Slough Demonstration Project.

(1) General. In June 1993, the U.S. Army Corps of Engineers, SFWMD, and ENP began another experimental water program known as the "Taylor Slough Demonstration Project". In addition to carrying on the Rain-Driven Water Deliveries, the Taylor Slough Demonstration Project returned the stage in L-31N Borrow Canal from 4.5 ft. to 5.0 ft., NGVD during the wet season. This was done to prevent seepage from water pumped into Taylor Slough at S-332 back into the L-31W borrow canal. In addition several portable diesel pumps were added to S-332 to bring the current pumping capacity to 365 cfs. Additional portable pumps will be added to bring the total capacity of S-332 to 500 cfs. Operating criteria for this test is contained in Addendum 6 of the Letters of Agreement. In November 1993, the Frog Pond farmers filed a complaint against the SFWMD and the Corps seeking an injunction to stop the test. The farmers claim that the higher water levels during the test are preventing them from preparing and planting their tomato crop. In the first hearing, the Federal Judge rejected the farmers motion for a temporary restraining order permitting the test to continue. It is expected that the farmers will continue to seek lower water levels to permit agricultural activities in the Frog Pond area to begin in October when market conditions are favorable.

(2) Test Results. Data from the Taylor Slough Demonstration Project is being collected by the South Florida Water Management District, Everglades National Park, Dade County Environmental Resources Management (DERM), and other agencies, and was

not available to be included in this General Reevaluation Report. However, several items were noted during the test as a direct result of the higher canal stages and increased pumping at S-332.

With the increased flows down Taylor Slough the Old Ingraham Highway (old Park entrance) was being overtopped. The old road had several small culverts and were insufficient to pass increased flows down the slough and ultimately to Florida Bay. The SFWMD is planning to remove 0.6 miles of the road to increase conveyance down the slough.

With the increased capacity at S-332 it was noticed that the marsh vegetation directly in front of the pump station was impeding flow down the slough. Water was mounding up in front of the pump station and overtopping the spoil bank to the north of S-332. The SFWMD removed vegetation directly in front of the pump station creating a clear get away channel early in the test.

c. Water Deliveries to the Eastern Panhandle of ENP via C-111. The purpose of S-18C is to maintain desirable water levels in the upstream reach of Canal 111 north of the structure, pass flood flows up to 40 percent SPF without exceeding design stages upstream, and act as a control point for water deliveries to the Eastern Panhandle of ENP. Gate operations are remotely controlled to maintain an optimum range between 2.0 and 2.4 feet, NGVD above the structure while making minimum monthly water releases for ENP as shown in Table A-10.

The purpose of S-197 is to maintain optimum water control stages in Canal 111 to prevent saltwater intrusion. Most of the time S-197 is closed to promote discharges from S-18C to spill from the canal banks in to the panhandle of the Everglades National Park. S-197 only releases water during major floods. Structure 197 was originally built as a slide-gate controlled three barrel 84-inch corrugated metal pipe culvert with an invert elevation of minus 8.0 with an earthen plug across C-111. It originally had 3 manually operated slide gates attached to the upstream end of the pipes. In 1990 the SFWMD constructed ten additional culverts with two metal slide gates at the face of each riser. The gates can be operated from the timber operating platform.

d. Modified Water Deliveries General Design Memorandum (GDM). The GDM presents a structural plan that will allow adequate operational flexibility to satisfy environmental objectives without adversely impacting developed areas. More recently, the Everglades Protection and Expansion Act of 1989 authorized acquisition of approximately 107,600 acres and modification of the C&SF Project to restore the Park's natural hydrologic conditions for restoration of its ecosystem. This Act authorized the construction of modifications to the Central and Southern Florida Project to improve water deliveries to the park and to the extent practicable permits steps to restore the natural hydrological conditions within the park. These modifications are "justified by the environmental benefits to be derived by the Everglades ecosystem in general and the park in particular". The plan being considered will also restore water flows through WCA No. 3B that would more closely match the pre-project conditions. Along with the C-111 plan, the structural features of the plan would enable enough operational flexibility to accomplish a wide range of operational strategies for meeting project objectives and environmental restoration.

The purpose of S-331 is to function as a component of the conveyance canal system to Everglades National Park. The system is designed to provide supplemental water from Water Conservation Area No. 3A to satisfy peak dry season demands of ENP and south Dade County agricultural users during a 1-in-10 year drought. S-331 is required to lift water to obtain adequate hydraulic head in the L-31N borrow canal to enable the southward conveyance of water. S-331 would be operated as necessary when stages in the downstream conveyance canals recede 1.5 ft. below their design optimums.

However, during the experimental water delivery program, concerns over increased water deliveries to Northeast Shark River Slough (NESRS) prompted a change in the way S-331 is operated. For the experimental water delivery program Restricted Rain-Driven Test, S-331 has been used to provide flood mitigation for residents of an area known as the 8-1/2 square mile area rather than its original water supply purpose. In the flood mitigation mode, discharge is performed in response to the stage at a groundwater monitoring well known as Angels Well. If the stage at Angels Well is below 6.0 ft., NGVD, discharge through S-331 will be made so as to maintain an average headwater of 5.0 ft. NGVD. If the stage at Angels Well exceeds 6.0 ft., NGVD, discharge is made to maintain and average headwater stage of 4.5 ft., NGVD until Angels Well drops to 5.7 ft., NGVD, whereupon the S-331 headwater is allowed to rise to 5.0 ft., NGVD. During any of these operations, the discharge of S-331 will be limited so as to not to cause downstream structures to exceed their design stages.

Currently, the Corps of Engineers is designing the Modified Water Deliveries to Everglades National Park plan. The proposed structural features will permit S-331 to return to its design purpose of providing water supply deliveries southward to Everglades National Park. The approved Modified Water Delivery plan provides flood mitigation to the residents of the 8-1/2 square mile area by the addition of levees and a pump station dedicated for mitigating the increased water deliveries into NESRS.

20. Hydraulic Design Criteria.

a. General. Hydraulic design criteria and procedures discussed here are in accordance with standard engineering practice and applicable provisions of Corps of Engineer Engineering Manuals and other technical guidance. Criteria used to address special and local conditions are in accordance with those used previously by the Jacksonville District relative to the Central & Southern Florida Project.

b. Existing Hydraulic Conditions. The Central and Southern Florida Project, Part V, Supplement 37 -- General Design Memorandum, South Dade County (September 12, 1963) presents the existing design condition water surface profiles for the project area. These have been reproduced and included in this report as plates A-10, A-11, and A-12. Plate A-10 shows hydraulic data for C-111 from Structure 18C to Structure 176, plate A-11 shows 3.4 miles of C-111E from its junction with C-111, and plate A-12 shows 11.4 miles of L-31N borrow canal from S-176 up to the drainage divide at S-173, adjacent to pump station S-331.

The existing design condition water surface profiles for the reach of C-111 from S-18C to the outfall at Barnes Sound have not been included here. The original C-111 design included S-18C, located upstream from the coast with the end of the canal open to Barnes Sound, as the canal's downstream salinity barrier. A number of elements in the environmental community feared that salt water would move up the canal and possibly contaminate the freshwater aquifer or spill over the south bank through the gaps destroying the portion of Everglades National Park south of C-111. During the construction of the canal, these interests became very vocal and mounted a campaign to have some sort of structure at the end of the canal. As part of the construction, a bypass for U.S. Highway 1 was used while the bridge over C-111 was constructed. About the time the bypass was to be removed, the controversy over the open end of the canal reached a peak. As a temporary solution, a plug and culvert structure (S-197) were placed in the canal immediately downstream of the U.S. Highway 1 bridge. The plug was to be removed for flood control purposes and also for passage of barges. However, the plug was never removed for navigation purposes. In 1989, the SFWMD modified S-197 by adding 10 culverts to increase the discharge capacity to 2,300 cfs.

The gaps along the southern bank of lower C-111 below S-18C have been subject to recent cleanout initiated by the local sponsor agency, SFWMD. This cleanout entailed removal of vegetation that had grown over gap getaway areas and restricted overland flow southward to the eastern panhandle of Everglades National Park.

c. Post-Project Hydraulic Conditions. Water surface elevations within Shark River Slough and Taylor Slough were determined with the 1X1 model. Elevations at hydraulic structures were determined by considering possible stages at locations in Shark River Slough and Taylor Slough at the structure sites. HEC-2 models were used to "backwater" to the structure from appropriate distances in the marsh to ensure proper design tailwater conditions. Where required, channels between marsh discharge points and pump stations to outlet structures were also checked to ensure proper design tailwater conditions were addressed.

Recent surveys taken as a result of the Hurricane Andrew recovery effort showed that the existing canals were in excellent condition with respect to required conveyance capability. The proposed project plan calls for canal capacities which are less than the original design in all reaches of the existing canal network. Therefore, enlargement of existing canals is required. New canal segments were designed according to the latest Corps of Engineers criteria.

d. Canal Characteristics.

(1) Design water surface in canals. Due to the limited head available in the canals, the design water surface was held to at or just below the existing ground along the canal. In the low areas adjacent to the coast, when ground elevation is less than 2 feet the design water surface was held as close as practicable to the ground elevation. In the back

areas where slope was available the design water surface was established at a minimum of 0.5 feet below ground elevation.

(2) Maximum permissible velocities. Since the canals are located in limestone of varying hardness with little or no overburden, a maximum velocity of 4.0 feet per second was considered permissible. However, because of slope-control design limitations, canal velocities do not exceed 1.6 feet per second.

(3) Side slopes. Side slopes of 1 vertical to 1 horizontal are based on the most economical stable slopes for limestone material found in the area.

(4) Cross-sections. Within the limitations of depth, canal sections are based on the most economical section that would carry the design discharge at the design water surface and slope.

(5) Transitions. Because of low design velocities, transition lengths were not critical elements of the design and are based on Corps design guidance.

(6) Roughness coefficients.

Earth Canals. All existing canals are located in limestone rock. A Manning's roughness coefficient "n" of 0.035 was used in the design of canal sections and tabulation of water surface profiles. This value has provided satisfactory results in past designs.

Concrete-lined Canals. Concrete-lined canals are proposed to convey discharge from pump stations to the marsh areas. A Manning's roughness coefficient "n" of 0.018 was chosen to simulate weathered concrete.

Marsh Flow Analyses. Analyses and calibration of storm discharges through Florida marshes have shown that Manning's roughness coefficient "n" values are usually in the range of 0.15 to 0.43. Roughness coefficient values as high a 1.0 for densely vegetated areas have been documented. The type of vegetation encountered in Shark River Slough and Taylor Slough is not expected to produce Manning's n-values in excess f of 0.40. However, sensitivity analyses were performed to determine the worst possible roughness conditions on flow.

(7) Sensitivity Analyses. Sensitivity analyses were done using HEC-2 to determine the response of the water surface profile to different vegetative growth densities. The purpose was to analyze head losses across a retention/detention area. Models were developed for a marsh reach extending from the discharge canal outfall area out about 0.5 miles into the wetland area. Photos A-1 and A-2 show aerial views of the marsh land adjacent to L-31W borrow canal near S-332. This can be considered typical for vegetation in this wetland area.

A range of wetland water surface stages were used for the starting water surface. These "tailwater" depths for the HEC-2 model represent probable water depths out in the marsh or slough, and ranged from a depth of 0.3 feet to 3.5 feet. Three roughness coefficients were used to model the marsh/wetland: Manning's n-value= 0.15, 0.43, and 1.0. These yielded maximum increases in depth at the discharge canal outfall of 1.6, 1.9, and 4.5 feet, respectively, for a "tailwater" depth in the marsh of 0.3 feet. Higher tailwater depths in the marsh tended to drown out the water surface profile rise at the discharge outfall. Results of these analyses were used in determining the maximum pumping head and top of discharge canal elevations.

(8) Freeboard. The project area has very little topographic relief. Consequently, canal designs were developed that would not provide freeboard. Water surface profiles for flood flows were set at the highest non-damaging levels.

e. Levees. In addition to flood control benefits, this project provides for enhancement of natural values within the project area by rerouting flow into areas to benefit flora and fauna. New levees proposed for the project include levees which block backflow from areas designated to have increased stages for environmental reasons. Adjacent and parallel existing levees, east of the proposed levees, would continue to provide protection for flood control.

Modifications to existing levees described in this report include levee segments that would be degraded to allow flow into an area acquired for environmental enhancement of Taylor Slough. Because of this, one new section of levee would be required to maintain flood protection to the east. That levee would divide the "Frog Pond" into two sections. The crest elevation of that levee was chosen to tie in to the remaining existing segments of levee. The same level of flood control would therefore be provided to the eastern segment of the Frog Pond and the areas east of C-111 above S-18C.

f. Water Control Structures. This plan presents no new spillway structure designs or modifications to existing spillways. There would be four 300 cfs pump stations and one 50 cfs pump station. The project requires continued operation of existing structures within normal operating ranges.

(1) Optimum and Design Water Levels. Optimum and design water levels in the project canals are established on the basis of desirable water control elevations in each area, i.e., optimum groundwater levels, intake and/or discharge structure elevations and removal rates for flood control. Along the east coast, salinity control is included as a requirement of canal-level design criteria.

(2) Salinity Control. The project area lies over the Biscayne Aquifer. The Biscayne Aquifer underlies about 3,000 square miles of Dade, Broward, and southern Palm Beach County. It is a surficial, highly permeable, wedge shaped aquifer that is about 200 feet thick at the coast but thins to a few feet thick near its western boundary 35 to 40 miles

inland. This aquifer, and surficial aquifers in Palm Beach County, provide water for municipal and industrial (M&I) water supply and agricultural irrigation along the southeast coast. Seepage and water supply releases from the Water Conservation Areas prevent saltwater intrusion along the coast and recharge the surficial aquifers. The original design considered that except at coastal salinity structures, canal stages in general would be permitted to recede approximately 1.5 feet below optimum levels before supplemental water was introduced into the ENP-South Dade Conveyance System. The alternatives evaluated would use this criteria, therefore it is anticipated that there would be no salinity encroachment.

g. Bridges. There is one shallow box culvert type bridge over Taylor Slough. It would be replaced by a 1000-foot long elevated roadway over the shallow slough.

h. Disposal Mound Areas. Existing disposal mounds along the south bank of the most southerly leg of C-111 would be removed and used as fill for the L-31W Tieback. Haul routes and the amount of material to be placed along L-31W Tieback are discussed in Appendix D, Design and Cost Estimates.

i. Sediment Potential. The project area is very flat, and project channels were designed with very little hydraulic slope. Such slope-controlled design result in very low velocities and little sediment movement through the canal system. Referring to the Jacksonville Districts's September 1992 C-111 Rehabilitation Report for damage from Hurricane Andrew, this report noted that relatively little shoal removal was required. For the reach of C-111 between S-177 and S-176, only about 0.2 feet of aggradation occurred on average over this canal reach for the more than 20 years project life. Based on this, it appears that the potential for loss of conveyance due to sediment is negligible.

21. Hydraulic designs.

a. Alternatives. Eight alternatives were developed, with two of these being slight modifications to other alternatives. Hydraulic designs were developed to maintain the authorized level of flood control and to protect the natural values associated with Everglades National Park, as discussed in the 1989 Everglades National Park Protect and Expansion Act. Alternative plans are described in detail in the main report. Brief descriptions of features are as follows.

(1) Plate A-1 shows alternative 1, which included enlarging S-174 to 1500 cfs capacity, enlarging S-332 to 1000 cfs capacity, adding a 50 cfs pump at Context Road, adding a spreader canal with a 50 cfs pump north of C-111, plugging C-109 and C-110, and degrading the spoil mounds along the southern leg of C-111.

(2) Plate A-2 shows alternative 1A, a slight modification to alternative 1. The spreader canal and 50 cfs pump are not a part of alternative 1A.

(3) Plate A-3 shows alternative 2. It calls for an additional 1000 cfs pump at S-174, backfill of a portion of L-31W borrow canal, and similar to alternative 1, the 50 cfs pump at Context Road, the spreader canal and 50 cfs pump north of C-111, plugs in C-109 and C-110, and degrading spoil mounds along the southern leg of C-111.

(4) Plate A-4 shows alternative 3. It calls for an additional 1630 cfs pump near S-174, and creation of a Stormwater Detention Area (SDA) with a surge pond in the Frog Pond area, backfill of the southern portion of L-31W borrow canal, and similar to alternative 1, a spreader canal with a 500 cfs pump station, plugs in C-109 and C-110, but backfill of C-111 from below the junction with C-111E to S-197.

(5) Plate A-5 shows alternative 4. It calls for an four additional 300 cfs pump station along a new levee that would run parallel with L-31N, modifications to S-357 and its seepage canal (these are a part of the Modified Water Deliveries for ENP Project, which has not yet been constructed), backfill of the upper portion of L-31W borrow canal, and similar to alternative 3, the spreader canal and 500 cfs pump north of C-111, plugs in C-109 and C-110, and backfill of the southern leg of C-111 from below the junction with C-111E to S-197.

(6) Plate A-6 shows alternative 5. It calls for an additional 1000 cfs pump stations near S-174, backfill of the lower portion of L-31W borrow canal, and similar to alternative 3, the spreader canal and 500 cfs pump north of C-111, plugs in C-109 and C-110, but only partial backfill of the southern leg of C-111 from below the junction with C-111E to S-197.

(7) Plate A-7 shows alternative 6. It can briefly be described as a combination of the upper part of alternative 4, which includes the four 300 cfs pump stations, new levee, modification to S-357 and its seepage levee, backfill of a segment of L-31W; and the lower portion of alternative 1, which includes adding a spreader canal with a 50 cfs pump north of C-111, plugging C-109 and C-110, and degrading the spoil mounds along the southern leg of C-111.

(8) Plate A-8 shows alternative 6A, the recommended plan. Upstream of the existing S-177, the plan of modifications is somewhat similar to alternative 6, and includes four 300 cfs pump stations, two new levees, and backfill of a segment of L-31W. The lower portion of the recommended plan is similar to alternative 1, which includes adding a spreader canal with a 50 cfs pump north of C-111, plugging C-109 and C-110, and degrading the spoil mounds along the southern leg of C-111. This plan is discussed in detail below.

b. Proposed Plan. The proposed plan for flood control and environmental restoration would maintain the existing flood protection. Plate A-8 presents the proposed modifications to the L-31(N)/C-111 canal system. The plan provides flexibility of water transfer from L-31N borrow canal and C-111 to various points along their alignments including the Context Road (Rocky Glades) area and Taylor Slough, and the east-west alignment of C-111 above the eastern panhandle of the Everglades National Park. The following description of actions and features necessary that make up the proposed plan is broken down into water transfer areas.

(1) The Rocky Glades area south of S-331 and west of L-31N, and Taylor Slough west of C-111 and south of S-175, would be served by modified as follows. Four new 300 cfs capacity pump stations would pump water from L-31N borrow canal westward toward Everglades National Park, across an area known as Rocky Glades. The four 300 cfs pump stations would be located along the existing L-31N borrow canal, and each would have a westward flowing concrete-lined getaway canal, to reduce back-seepage to the L-31N borrow canal.

The getaway canals would terminate just past the first of two new levees, designated S-332D Tieback; the second levee, designated L-31W Tieback, would be parallel to and 0.5 miles further west. This pair of levees would provide for separation of the agricultural areas to the east from the Everglades National Park to the west. The area bounded on the east by the existing L-31N and on the west by the new S-332D Tieback levee would be a buffer zone. The area bounded on the east by the new S-332D Tieback levee and on the west by the new L-31W Tieback would be a retention/detention zone. The L-31W Tieback would have twenty-four 36-inch culvert-risers spaced at 1000-foot intervals, for spreading flow westward into Everglades National Park. A typical profile of flow from L-31N borrow canal through the buffer zone, the retention/detention area, and into ENP is shown on plate A-9.

Adjacent to the area known as the Frog Pond, a segment of the L-31W borrow canal would be filled in from S-332 northward to where the western-most new levee (L-31W Tieback) crosses north to south. The existing canal would be filled to natural grade. Backfill material will be taken from the adjacent levee L-31W. The purpose is to encourage sheet flow toward Taylor Slough and to restore flow to the historic flood plain within the Frog Pond. Pump station S-332 would remain in service. A connector canal from C-111 would provide water to the west (to S-332) and south (to S-175). The L-31W levee would be severed near S-175, to provide a connection for the connector canal and the L-31W canal. Three sections of the Frog Pond areas would have to be acquired to serve as floodway for this alternative and the five remaining sections would act as a buffer zone.

(2) The eastern Panhandle area of Everglades National Park (ENP), south of the east-west run of C-111, would be modified as follows. A new canal, designated Canal 111 North (C-111N) would be constructed to increase water supply for environmental restoration of the area. The C-111N would receive pumped water from existing C-111E and provide conveyance east with overflow going south. Water from C-111E would be pumped by a new 50 cfs pump station, designated S-332E. Canal 111 North would act as a spreader canal. Water would pass over the south bank and be conveyed as sheet flow southward. A berm would be placed on the north bank to minimize the impact on stages north of the spreader canal.

Existing canals C-109 and C-110 were constructed by side casting methods which created spoil berms on the east and west banks of both canals. Nine plugs would be constructed in C-109 and ten plugs would be constructed in C-110. These plugs would overdraining to the wetlands. Material for construction of the plugs would be obtained from adjacent spoil mounds. A typical plug would be 200 feet long with a top elevation equal to the adjacent natural grade. East and west bank spoil mounds at the north end of each plug would be joined to prevent water from entering unplugged sections of the canals. This procedure would also be followed at the south end of each plug.

There are spoil banks along the east-west run of C-111 upstream of S-197. On the south bank, gaps were left to allow flow southward into the panhandle area of ENP. The proposed plan provides for removal of all spoil along this southern bank of C-111. This spoil would be used as levee fill material for the new levee, L-31W Tieback.

c. Pump Stations. The four new pump stations along the new levee would each have 300 cfs capacity. They are numbered S-332A, S-332B, S-332C, and S-332D and their locations are shown on plate A-8. Each pump station would be equipped with four 75 cfs capacity pumps. Hydraulic design data for these pumps are shown in tables marked table A-11, Table A-12, Table A-13, and Table A-14, respectively.

A 50 cfs pump station, S-332E, would pump water into a new canal, designated C-111N. Water would be pumped from the junction of C-111 and C-111E and provide for flows to the east across canals C-109 and C-110. Hydraulic design data for this pump is shown in Table A-15.

d. Canals.

(1) Pump Stations S-332A & S-332B Discharge Canals. Pump stations S-332A and S-332B would discharge water into 0.5-mile long concrete-lined canals extending westerly from L-31N borrow canal across the buffer zone. The purpose of the concrete lining is to inhibit seepage and reduce pumping of return flow by increasing the seepage flow path back to the L-31W borrow canal. This is typical for all four pump station discharge canals. A schematic plan and profile sketch is shown on plate A-9. The S-332A and S-332B discharge canals would each have a 10-foot bottom width, 1 to 1 side slopes, and an invert of 3.2 feet, NGVD. The top of channel would be at elevation 10.5 feet, NGVD. A berm would be required on each side of the canal, since existing ground elevations are about 7 feet, NGVD, in this area. Figure A-6 shows a schematic water surface profile extending from the pump station down the discharge canal, across the retention/detention area, and through the culvert/riser.

(2) Pump Station S-332C Discharge Canal. Pump station S-332C would discharge water into a 0.5-mile long concrete-lined canal extending westerly from L-31N Borrow Canal. This canal would have a 10-foot bottom width, 1 to 1 side slopes, and an invert of 2.7 feet, NGVD. The top of channel would be at elevation 9.8 feet, NGVD. A

berm would be required on each side of the canal, since existing ground elevations are about 6.5 feet, NGVD, in this area. A schematic profile sketch of this canal is shown on plate A-9. Figure A-6 shows a schematic water surface profile extending from the pump station down the discharge canal, across the retention/detention area, and through the culvert/riser.

(3) Pump Station S-332D Discharge Canal. Pump station S-332D would be placed immediately downstream of S-174, and discharge water into the existing L-31W borrow canal. This canal would be concrete-lined for about one-half mile, extending westerly from L-31N Borrow Canal. A schematic plan layout is shown on plate A-9. The top of channel would be at elevation 9.3 feet, NGVD. The S-332D Tieback berm would be constructed along the north side of the canal, where existing ground elevations are about 6.5 feet, NGVD.

(4) Pump Station S-332 Connector Canal. Existing pump station S-332 would remain in service. A connector canal from C-111 would provide water to the west (to S-332) and south (to S-175). A culvert structure, discussed in paragraph 21(f) below, would be placed on the existing L-31W borrow canal, and the proposed connector canal would extend eastward form this point to C-111. A schematic plan view layout is shown in figure A-7. The connector canal would have a 10-foot bottom width, 1 to 1 side slopes, and an invert of -12.0 NGVD.

(5) Canal 111 North (spreader canal). A 50 cfs pump station, S-332E, would pump water into a spreader canal designated the C-111N. Water would be pumped from the junction of C-111 and C-111E and provide for flows to the east across canals C-109 and C-110. Hydraulic design data for this canal is shown in Table A-16. A schematic profile of the canal and water surface is shown on Figure A-8. Figure A-9 shows how the flow would rise and exit the canal, as sheet flow moving southward.

(6) Existing Canals C-109 and C-110. Earth plugs would be placed in C-109 and C-110, for the purpose of allowing flow to spread and sheet flow in a more natural manner southward from the new C-111N.

e. Levees.

(1) Levee 31 West Tieback. A new north-south levee would be created that would run parallel to L-31N, designated L-31W Tieback. It would be located about one mile west of L-31N, and have two segments that would tie-into the existing L-31W. The northern segment would extending the existing L-31W west of S-14 to high ground in the Rocky Glades area. This northern segment of levee would form the western boundary of a retention/detention area. The levee top would be about four feet above existing ground elevations.

The northern segment of the proposed L-31W Tieback and the S-332D Tieback levee discussed below would create a retention/detention area between ENP to the west and agricultural lands to the east. The L-31W Tieback levee would also have riser culverts through it and an emergency spillway. The culverts and the emergency spillway are discussed in paragraphs 21(e) and 21(f), above.

The southern segment of L-31W Tieback would run southerly from an existing segment of L-31W, crossing the bottom leg of the existing L-31W at a proposed culvert structure in the L-31W borrow canal to tie in to S-175. The levee top would be about three to four feet above existing ground elevations. Levee top elevations are shown in Table A-17. Borrow material for the L-31W Tieback levee would come from the south bank disposal mounds on the southern most leg of C-111.

(2) S-332D Tieback. An additional new north-south levee would be created that would run parallel to L-31N, designated S-332D Tieback. It would be located about one-half mile west of L-31N, bisecting the lands between the existing L-31N and the proposed L-31W Tieback. The northern terminus of S-332D Tieback would tie into high ground in the Rocky Glades area, somewhat north and one-half mile west of the junction of C-102 and L-31N borrow canal. A southern segment of the levee would turn eastward and run parallel to L-31W about one-half mile west of L-31N, and tie into a new pump station that would be located immediately west of S-174. The levee top would be about three to four feet above existing ground elevations. Levee top elevations are shown in table A-18. Borrow material for this levee would come from either the existing disposal mounds along C-111, or an adjacent borrow canal. This borrow canal would not be continuous, and it would not carry flow.

As noted above, the northern segment of the proposed L-31W Tieback and the S-332D Tieback levee would create a retention/detention area, west of the S-332D Tieback levee. The area east of the S-332D Tieback levee to the existing L-31N would create a buffer zone between the retention/detention area to the west and agricultural lands to the east.

(3) Modifications to Existing L-31W. A long segment of L-31W, extending from the tie-in with the new L-31W Tieback southward to existing pump station S-332, would be totally degraded as shown on plate A-8. This segment encompasses the western-most part of the Frog Pond. The levee material would be returned to the adjacent borrow canal.

(4) Modifications to Existing Berms along C-111. There are disposal banks along the east-west run of C-111 upstream of S-197. On the south bank, gaps were left to allow flow southward into the panhandle area of ENP. The proposed plan provides for removal of all disposal mounds along this southern bank of C-111. The spoil would be deposited in C-109 and C-110, and used in levee construction, as described above.

f. Culvert/Riser Structures.

(1) Culverts through L-31W Tieback. Culvert/riser structures would be provided to convey water from the retention/detention area westward toward Everglades National Park. Twenty-four 36-inch diameter culvert/risers would be placed through L-31W Tieback at 1000-foot intervals. The culverts were sized to pass 50% of the maximum pump capacity of the three pump stations S-332B, S-332C, and S-332D, with 0.5 feet of head difference. An overflow spillway, described below, would pass the balance of the pump capacity. The 1000-foot spacing is based on providing dispersion of flow into Everglades National Park. Hydraulic design data for a typical culvert is shown in table A-19. Figure A-6 shows a schematic water surface profile extending from the pump station down the discharge canal, across the retention/detention area, and through the culvert/riser.

The culverts would be set so that the pipe soffit is at adjacent grade, and would have a 10-foot wide exit sump as shown in the sketch on plate A-9. The riser would have a moveable plate to adjust discharges.

(2) Culvert from C-111 Connector Canal to S-332. Since existing pump station S-332 would remain in service, a connector canal from C-111 would provide water to the west (to S-332) and south (to S-175). A culvert structure on the existing L-31W borrow canal would pass water to S-332, with a flap-gate on the west end to prohibit backflow toward C-111. The proposed L-31W Tieback would tie into this structure. A schematic plan view layout is shown in Figure A-7. Hydraulic design data for the culvert is provided in table A-20.

g. Overflow Spillway on L-31W Tieback. There would be one overflow spillway across L-31W Tieback, as shown on plate A-8. It would be a trapezoidal spillway, with a length of 300 feet. As shown in figure A-10, the spillway would be a 1-foot notch in the levee, with 1 on 10 ramps down to the spillway crest. The downstream spillway face would be armored as shown in the figure, for a design velocity of 4 feet per second and depth of 1 foot.

The spillway crest length was determined to pass 50% of the maximum pump capacity of the three pump stations S-332B, S-332C, and S-332D. The culvert/risers would pass the balance of the pump capacity.

h. Bridges. An elevated roadway is proposed for the segment of State Road 9336 (State Road 27) that crosses Taylor Slough within Everglades National Park. There is an existing shallow box culvert crossing of Taylor Slough that is about 60 feet long. This can be seen in Photo A-3. The new bridge would replace this crossing with a 1000-foot long concrete bridge, built next to the existing SR 9336. This would provide for continuous access during construction of the new bridge. After new approaches are connected to the bridge from SR 9336, the old road bed and box culverts would be removed. The bridge low cord would be set at 2.5 feet above the maximum target stage in Taylor Slough of 6.5 feet, NGVD. Riprap would not be required because velocities would be less than 1.5 feet per second.

The Old Ingraham Highway also crosses Taylor Slough, downstream and south of State Road 9336. There is no bridge on this unpaved road, which was constructed in the early 1910's. Photo A-4 is an eastward facing aerial view of the road. The SFWMD has removed 0.6 miles of this road as part of the Taylor Slough Demonstration Project.

i. Existing Canals and Water Control Structures.

(1) Table A-21 lists as-built canal data. Locations are shown on plate A-1. The Levee 31 West borrow canal, Canal 111, and Canal 111 East are hydraulically linked and hydrologically inseparable. They provide drainage for both the C-111 basin and the Taylor Slough basin. The canal systems discharge into Everglades National Park at important hydrological and environmental locations. The system is designed to distribute normal and flood discharges between the natural Taylor Slough basin and the eastern panhandle of Everglades National Park.

The Levee 31 North borrow canal was designed to discharge agricultural runoff southward to the L-31W borrow canal and/or C-111. This canal is also used for conveyance of water supply deliveries to Everglades National Park and to coastal canals. Photo A-5 was taken looking north along the alignment of L-31N, near S-176.

The west leg of L-31W was designed to prevent flooding from the Everglades area from causing damage in the agricultural and industrial areas to the east. The existing levee extends from its junction with L-31N to the Everglades National Park boundary, which it then follows southward for about 8 miles. Photo A-6 is a westward view into ENP from just north of pump station S-332, across the L-31W borrow canal. The L-31W borrow canal was designed to discharge flood releases and water supply discharges to replenish fresh water supply in Taylor Slough.

Canal 111 East originates at State Road 27, four-tenths of a mile west of Country Club Road. The canal extends three miles to the south to its open channel junction with C-111. Flow in the canal is to the south. C-113 begins at Richard Road on-fourth mile north of Mowery Drive and extends west to its open channel junction with C-111 just downstream of S-176. Flow in C-113 is to the west. C-111E and C-113 have the following functions: (1) provide drainage and flood protection for the C-111 basin; (2) supply water to the C-102, C-103, and C-111 basins, and to Everglades National Park; (3) prevent slat water intrusion into local groundwater.

Canal 111 was designed for flood protection. During a flood event, a portion of the Taylor Slough basin runoff is discharged down C-111. Photo A-7 is a view of the south bank of C-111, with one of the recently cleaned out gaps that provides for flow toward the panhandle area of ENP. The southern portion of the C-111 basin was to have been drained by C-109 and C-110. C-109 was completed and C-110 was partially completed before work on these canals was stopped. Earthen plugs have been placed at the confluence of these canals with C-111. Neither canal has a connection with C-111.

(2) Table A-22 lists as-built structure data for S-174, S-175, S-176, S-177, S-18C, S-197, and S-332. The following are design functions of the existing structure works. Locations are shown on Plate A-1.

Structure 174 is a gated-spillway located in the east end of L-31W borrow canal and near the intersection of the existing C-111, Section 3 Extension, and L-31N borrow canal. Photo A-8 looks west at S-174. S-174, together with S-176, maintains a desirable water control stage upstream in L-31N borrow canal, passing releases to L-31W. It passes the design flood (40 percent of the SPF) without exceeding the upstream flood design stage, and restricts downstream flood stages and discharge velocities to non-damaging levels. It also passes the required flows (up to 500 cfs) to Taylor Slough in Everglades National Park. During low-flow periods, S-174 can pass sufficient discharges to maintain stages downstream.

S-175 is a gated, three barrel, 84-inch corrugated metal pipe culvert with reinforced concrete headwalls, located near the top of the most southerly leg of L-31W borrow canal. Photo A-9 shows the upstream side of S-175. This structure maintains optimum upstream water control stages in the L-31W borrow canal. It passes the design flood (40 percent of the SPF) without exceeding the upstream flood design stage, and restricts downstream flood stages and channel velocities to non-damaging levels. S-175 operates to discharge the flow from S-174 and to support an optimum upstream water elevation of 4.5 ft. Under flood control operations, this structure diverts the L-31W borrow canal discharge overload into Taylor Slough or passes it south to distribute the flow overland from L-31W borrow canal to south of State Road 27.

Structure 176 is a gated-spillway located in the south end of L-31N borrow canal. Photo A-10 shows the upstream side of S-176. S-176, together with S-174, maintains a desirable water control stage upstream in L-31N borrow canal. It passes the design flood (40 percent of the SPF) without exceeding the upstream flood design stage, and restricts downstream flood stages and discharge velocities to non-damaging levels. During low-flow periods, S-176 can pass sufficient discharges to maintain stages downstream.

Structure 177 is located in Canal 111, 300 feet south of State Road 27. S-177 is a reinforced concrete, one bay, U-shaped spillway with automatically controlled vertical-lift gate and manually operated slide gates. Photo A-11 is a view looking downstream at S-177. This structure maintains optimum water control upstream in Canal 111. It passes the design flood (40 percent of the SPF) without exceeding the upstream flood design stage, and restricts downstream flood stages and discharge velocities to non-damaging levels. During low-flow periods, S-177 can maintain desirable water control conditions upstream in Canal 111.

S-178 is a gated culvert located in C-111E at State Road 27. It controls local inflows to C-111E from local drainage. Photo A-12 is a view of S-178 looking upstream. The structure maintains desirable water control stages upstream from the structure during low flow period; passes all discharges up to the design capacity without exceeding desirable stages; and restricts discharge during floods to that which will not cause damaging velocities or stage downstream.

S-194 is a gated culvert located in C-102 on the divide between the C-102 and C-111 basins. The structure is normally open to supply water to the C-102 basin from L-31N borrow canal. During flooding the gates at S-194 are closed to prevent water from passing from one basin to another.

S-196 is a gated culvert located in C-103 on the divide between the C-103 and C-111 basins. The structure is normally open to supply water to the C-103 basin from L-31N borrow canal. During flooding the gates at S-196 are closed to prevent water from passing from one basin to another.

Structure 18C is located in Canal 111, Section 1. Control structure S-18C is a two bay, U-shaped gated spillway, with a trapezoidal weir and cable operated vertical-lift gates with slide gates. Photo A-13 shows the gates out of the water at S-18C. S-18C maintains a desirable freshwater head against northerly salt water intrusion into Canal 111. The structure maintains optimum water control stages upstream in Canal 111; it passes the design flood (40 percent of the SPF) without exceeding upstream flood design stage, and restricts downstream flood stages and discharge velocities to non-damaging levels and assists in preventing saline intrusion. It also makes discharges to the eastern panhandle of the Everglades National Park.

Structure 197 is in Canal 111 near the mouth of the canal, about 3 miles from Manatee Bay and 750 ft. east of U.S. Highway 1. S-197 was originally built as a gated, three barrel, 84-inch, corrugated metal, pipe culvert with an invert elevation of -8.0 feet. It originally had 3 manually operated slide gates attached to the upstream end of the pipes. In 1990, the local sponsor (SFWMD) built ten additional culverts. Photo A-14 shows the three original culverts and the ten additional culverts adjacent. S-197 maintains optimum water control stages in Canal 111 and prevents saltwater intrusion during high tides. Usually S-197 is closed, which forces discharge from S-18C overland to the panhandle of the Everglades National Park. S-197 releases water only during major floods under established guidelines.

Structure 332 is located at the head of Taylor Slough in the Everglades National Park about 6 miles west of Homestead, Florida. It is on the west side of L-31(W) borrow canal, as shown in Photos A-1 and A-2. S-332 is an electric motor-driven pumping station with a variable pump arrangement. Its purpose is to function as a component of the conveyance canal system to ENP and South Dade County, and provide water to ENP. Under normal regulation, S-332 is required to deliver a minimum of 37,000 acre-feet of water per year from L-31(W) borrow canal to Taylor Slough in ENP. These flows are subject to water availability. During flood periods S-332 may exceed the monthly rate, up to the capacity of the pumping station, upon mutual agreement of the National Park Service, the South Florida Water Management District, and the U. S. Army Corps of Engineers.

j. Performance/water surface profiles. Water surface profiles are shown on plates A-10, A-11, and A-12. The design water surface profiles are based on a flood recurrence interval of 1 in 10-years. The measures proposed in this document are designed to provide environmental enhancement and increased water supply to Everglades National Park (ENP). Flood control capabilities of the existing system will also be increased somewhat. Flood protection is currently provided by the alignment and height of levees L-31N and L-31W, and conveyance capabilities of canal C-111. Proposed project features would provide for redirection of the majority of C-111 flood discharges directly to ENP. This would allow reduced discharge requirements at S-197 and thus reduce freshwater discharge to Florida Bay. The proposed features would not compromise existing flood control capabilities. Benefits to agricultural lands and residential properties would not be reduced and flood risk to people in the project areas would not be increased.

C-111
GENERAL REEVALUATION REPORT
Appendix A
Hydrology and Hydraulic Analysis

TABLES

DEPTH–AREA IN PERCENT OF POINT RAINFALL FOR 1X1 MODEL FOR STORM CENTERED OVER C111

DURATION	RATIO	RAINGAGE NUMBER												
DAYS	TO 1 DAY	7	6	10	4	1	8	3	2	5	9	11	13	12
1	1.000	94.5	91.7	90.5	89.3	88.5	87.8	87.3	87	86.7	86.3	80.4	80.4	80.4
2	1.016	96.0	93.2	91.9	90.7	89.9	89.2	88.7	88.4	88.1	87.7	81.7	81.7	81.7
3	1.023	96.7	93.8	92.6	91.4	90.5	89.8	89.3	89.0	88.7	88.3	82.2	82.2	82.2
4	1.028	97.1	94.3	93.0	91.8	91.0	90.3	89.7	89.4	89.1	88.7	82.7	82.7	82.7
5	1.031	97.4	94.5	93.3	92.1	91.2	90.5	90.0	89.7	89.4	89.0	82.9	82.9	82.9
6	1.034	97.7	94.8	93.6	92.3	91.5	90.8	90.3	90.0	89.6	89.2	83.1	83.1	83.1
7	1.036	97.9	95.0	93.8	92.5	91.7	91.0	90.4	90.1	89.8	89.4	83.3	83.3	83.3
8	1.037	98.0	95.1	93.8	92.6	91.8	91.0	90.5	90.2	89.9	89.5	83.4	83.4	83.4
9	1.038	98.1	95.2	93.9	92.7	91.9	91.1	90.6	90.3	90.0	89.6	83.5	83.5	83.5
10	1.039	98.2	95.3	94.0	92.8	92.0	91.2	90.7	90.4	90.1	89.7	83.5	83.5	83.5
11	1.040	98.3	95.4	94.1	92.9	92.0	91.3	90.8	90.5	90.2	89.8	83.6	83.6	83.6
12	1.041	98.4	95.5	94.2	93.0	92.1	91.4	90.9	90.6	90.3	89.8	83.7	83.7	83.7
13	1.043	98.6	95.6	94.4	93.1	92.3	91.6	91.1	90.7	90.4	90.0	83.9	83.9	83.9
14	1.044	98.7	95.7	94.5	93.2	92.4	91.7	91.1	90.8	90.5	90.1	83.9	83.9	83.9
15	1.045	98.8	95.8	94.6	93.3	92.5	91.8	91.2	90.9	90.6	90.2	84.0	84.0	84.0
16	1.046	98.8	95.9	94.7	93.4	92.6	91.8	91.3	91.0	90.7	90.3	84.1	84.1	84.1
17	1.046	98.8	95.9	94.7	93.4	92.6	91.8	91.3	91.0	90.7	90.3	84.1	84.1	84.1
18	1.047	98.9	96.0	94.8	93.5	92.7	91.9	91.4	91.1	90.8	90.4	84.2	84.2	84.2
19	1.047	98.9	96.0	94.8	93.5	92.7	91.9	91.4	91.1	90.8	90.4	84.2	84.2	84.2
20	1.048	99.0	96.1	94.8	93.6	92.7	92.0	91.5	91.2	90.9	90.4	84.3	84.3	84.3

TABLE A–1

C-111 10-YR STORM FOR 13 RAINFALL BASINS

DAY	POINT RAINFALL	7	6	10	4	1	8	3	2	5	9	11	13	12
1	0.45	0.45	0.43	0.43	0.42	0.42	0.41	0.41	0.41	0.41	0.41	0.38	0.38	0.38
2	0.50	0.49	0.48	0.47	0.47	0.46	0.46	0.46	0.46	0.45	0.45	0.42	0.42	0.42
3	0.50	0.49	0.48	0.47	0.47	0.46	0.46	0.46	0.46	0.45	0.45	0.42	0.42	0.42
4	0.50	0.49	0.48	0.47	0.47	0.46	0.46	0.46	0.45	0.45	0.45	0.42	0.42	0.42
5	0.55	0.54	0.53	0.52	0.51	0.51	0.50	0.50	0.50	0.50	0.49	0.46	0.46	0.46
6	0.60	0.59	0.57	0.56	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.50	0.50	0.50
7	0.60	0.59	0.57	0.56	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.50	0.50	0.50
8	0.70	0.68	0.66	0.66	0.65	0.64	0.64	0.63	0.63	0.63	0.62	0.58	0.58	0.58
9	0.75	0.73	0.71	0.70	0.69	0.68	0.68	0.67	0.67	0.67	0.67	0.62	0.62	0.62
10	2.00	1.92	1.86	1.84	1.81	1.80	1.78	1.77	1.77	1.76	1.75	1.63	1.63	1.63
11	6.75	6.38	6.19	6.11	6.03	5.97	5.93	5.89	5.87	5.85	5.83	5.43	5.43	5.43
12	0.80	0.77	0.75	0.74	0.73	0.72	0.72	0.71	0.71	0.71	0.71	0.66	0.66	0.66
13	0.70	0.68	0.66	0.65	0.64	0.64	0.63	0.63	0.63	0.63	0.62	0.58	0.58	0.58
14	0.65	0.64	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.58	0.58	0.54	0.54	0.54
15	0.60	0.59	0.57	0.56	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.50	0.50	0.50
16	0.55	0.54	0.52	0.52	0.51	0.51	0.50	0.50	0.50	0.50	0.49	0.46	0.46	0.46
17	0.55	0.54	0.53	0.52	0.51	0.51	0.50	0.50	0.50	0.50	0.50	0.46	0.46	0.46
18	0.50	0.49	0.48	0.47	0.47	0.46	0.46	0.46	0.45	0.45	0.45	0.42	0.42	0.42
19	0.50	0.49	0.48	0.47	0.47	0.46	0.46	0.46	0.46	0.45	0.45	0.42	0.42	0.42
20	0.45	0.45	0.43	0.43	0.42	0.42	0.41	0.41	0.41	0.41	0.41	0.38	0.38	0.38

C-111 2-YEAR STORM FOR 13 RAINGAGE BASINS

AREALLY REDUCED RAINFALL IN INCHES FOR 13 RAINGAGE BASINS AS NUMBERED

DAY	POINT RAINFALL	7	6	10	4	1	8	3	2	5	9	11	13	12
1	0.35	0.35	0.34	0.33	0.33	0.32	0.32	0.32	0.32	0.32	0.32	0.29	0.29	0.29
2	0.40	0.35	0.34	0.33	0.33	0.32	0.32	0.32	0.32	0.32	0.32	0.29	0.29	0.29
3	0.40	0.40	0.38	0.38	0.37	0.37	0.37	0.37	0.36	0.36	0.36	0.34	0.34	0.34
4	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.34	0.34	0.34
5	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.33	0.33	0.33
6	0.40	0.39	0.38	0.38	0.37	0.37	0.36	0.36	0.36	0.36	0.36	0.33	0.33	0.33
7	0.45	0.44	0.43	0.42	0.42	0.41	0.41	0.41	0.41	0.40	0.40	0.38	0.38	0.38
8	0.45	0.44	0.43	0.42	0.42	0.41	0.41	0.41	0.40	0.40	0.40	0.37	0.37	0.37
9	0.70	0.68	0.66	0.65	0.64	0.64	0.63	0.63	0.63	0.62	0.62	0.58	0.58	0.58
10	1.15	1.10	1.07	1.06	1.04	1.03	1.03	1.02	1.02	1.01	1.01	0.94	0.94	0.94
11	4.10	3.87	3.76	3.71	3.66	3.63	3.60	3.58	3.57	3.55	3.54	3.30	3.30	3.30
12	0.75	0.73	0.70	0.69	0.69	0.68	0.67	0.67	0.67	0.67	0.66	0.62	0.62	0.62
13	0.50	0.49	0.47	0.47	0.46	0.46	0.45	0.45	0.45	0.45	0.44	0.41	0.41	0.41
14	0.45	0.44	0.43	0.42	0.42	0.41	0.41	0.41	0.41	0.40	0.40	0.37	0.37	0.37
15	0.45	0.44	0.43	0.42	0.42	0.41	0.41	0.41	0.41	0.40	0.40	0.38	0.38	0.38
16	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.33	0.33	0.33
17	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.34	0.34	0.34
18	0.40	0.40	0.38	0.38	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.34	0.34	0.34
19	0.40	0.40	0.38	0.38	0.37	0.37	0.37	0.37	0.36	0.36	0.36	0.34	0.34	0.34
20	0.35	0.35	0.34	0.33	0.33	0.32	0.32	0.32	0.32	0.32	0.32	0.29	0.29	0.29

TABLE A-2

C-111 50-YR STORM FOR 13 RAINGAGE BASINS

AREALLY REDUCED RAINFALL IN INCHES FOR 13 RAINGAGE BASINS AS NUMBERED

DAY	POINT RAINFALL	7	6	10	4	1	8	3	2	5	9	11	13	12
1	0.60	0.59	0.58	0.57	0.56	0.56	0.55	0.55	0.55	0.55	0.54	0.51	0.51	0.51
2	0.65	0.64	0.62	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.55	0.55	0.55
3	0.65	0.64	0.62	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.55	0.55	0.55
4	0.65	0.64	0.62	0.61	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.55	0.55	0.55
5	0.65	0.64	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.58	0.54	0.54	0.54
6	0.65	0.64	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.58	0.54	0.54	0.54
7	0.70	0.69	0.67	0.66	0.65	0.64	0.64	0.63	0.63	0.63	0.63	0.58	0.58	0.58
8	0.75	0.73	0.71	0.70	0.69	0.69	0.68	0.68	0.67	0.67	0.67	0.62	0.62	0.62
9	0.75	0.73	0.71	0.70	0.69	0.68	0.68	0.67	0.67	0.67	0.67	0.62	0.62	0.62
10	2.45	2.35	2.28	2.25	2.22	2.20	2.19	2.17	2.17	2.16	2.15	2.00	2.00	2.00
11	9.75	9.21	8.94	8.82	8.71	8.63	8.56	8.51	8.48	8.45	8.41	7.84	7.84	7.84
12	0.80	0.77	0.75	0.74	0.73	0.72	0.72	0.71	0.71	0.71	0.71	0.66	0.66	0.66
13	0.75	0.73	0.71	0.70	0.69	0.68	0.68	0.68	0.67	0.67	0.67	0.62	0.62	0.62
14	0.70	0.69	0.67	0.66	0.65	0.64	0.64	0.63	0.63	0.63	0.63	0.58	0.58	0.58
15	0.70	0.69	0.67	0.66	0.65	0.64	0.64	0.63	0.63	0.63	0.63	0.58	0.58	0.58
16	0.65	0.64	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.58	0.54	0.54	0.54
17	0.65	0.64	0.62	0.61	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.55	0.55	0.55
18	0.65	0.64	0.62	0.61	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.55	0.55	0.55
19	0.65	0.64	0.62	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.55	0.55	0.55
20	0.60	0.59	0.58	0.57	0.56	0.56	0.55	0.55	0.55	0.54	0.54	0.51	0.51	0.51

C-111 100-YR STORM FOR 13 RAINFALL BASINS

AREALLY REDUCED RAINFALL IN INCHES FOR 13 RAINGAGE BASINS AS NUMBERED

DAY	POINT RAINFALL	7	6	10	4	1	8	3	2	5	9	11	13	12
1	0.65	0.64	0.62	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.55	0.55	0.55
2	0.65	0.64	0.62	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.55	0.55	0.55
3	0.70	0.69	0.67	0.66	0.65	0.65	0.64	0.64	0.64	0.63	0.63	0.59	0.59	0.59
4	0.70	0.69	0.67	0.66	0.65	0.65	0.64	0.64	0.64	0.63	0.63	0.59	0.59	0.59
5	0.70	0.69	0.67	0.66	0.65	0.64	0.64	0.64	0.63	0.63	0.63	0.59	0.59	0.59
6	0.70	0.69	0.67	0.66	0.65	0.64	0.64	0.63	0.63	0.63	0.63	0.58	0.58	0.58
7	0.75	0.73	0.71	0.70	0.69	0.69	0.68	0.68	0.68	0.67	0.67	0.63	0.63	0.63
8	0.75	0.73	0.71	0.70	0.69	0.69	0.68	0.68	0.67	0.67	0.67	0.62	0.62	0.62
9	0.80	0.78	0.75	0.74	0.73	0.73	0.72	0.72	0.72	0.71	0.71	0.66	0.66	0.66
10	2.70	2.59	2.52	2.48	2.45	2.43	2.41	2.39	2.39	2.38	2.37	2.21	2.21	2.21
11	11.00	10.40	10.09	9.96	9.82	9.74	9.66	9.60	9.57	9.54	9.49	8.84	8.84	8.84
12	0.80	0.77	0.75	0.74	0.73	0.72	0.72	0.71	0.71	0.71	0.71	0.66	0.66	0.66
13	0.75	0.73	0.71	0.70	0.69	0.68	0.68	0.68	0.67	0.67	0.67	0.62	0.62	0.62
14	0.75	0.73	0.71	0.70	0.69	0.69	0.68	0.68	0.68	0.67	0.67	0.62	0.62	0.62
15	0.70	0.69	0.67	0.66	0.65	0.64	0.64	0.63	0.63	0.63	0.63	0.58	0.58	0.58
16	0.70	0.69	0.67	0.66	0.65	0.64	0.64	0.64	0.63	0.63	0.63	0.59	0.59	0.59
17	0.70	0.69	0.67	0.66	0.65	0.65	0.64	0.64	0.64	0.63	0.63	0.59	0.59	0.59
18	0.70	0.69	0.67	0.66	0.65	0.65	0.64	0.64	0.64	0.63	0.63	0.59	0.59	0.59
19	0.65	0.64	0.62	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.55	0.55	0.55
20	0.65	0.64	0.62	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.55	0.55	0.55

TABLE A-3

STORM CATEGORIES
HOMESTEAD EXPERIMENT STATION

Number of Days with Rainfall Greater or Equal to Values Shown During Period of Record (1914 - 1977)

MONTH	3"	4"	5"	6"	7"	8"
JAN	-	-	-	-	-	-
FEB	-	-	-	-	-	-
MAR	3	2	-	-	-	-
APR	6	3	2	1	-	-
MAY	15	8	4	2	1	-
JUN	21	13	7	4	-	-
JUL	7	1	-	-	-	-
AUG	4	2	-	-	-	-
SEP	25	10	3	2	2	-
OCT	22	10	8	1	1	1
NOV	2	1	1	-	-	-
DEC	-	-	-	-	-	-

Number of 5-Day Total Rainfall Depths Greater Than or Equal to Values Shown (1914 - 1977)

MONTH	5"	6"	7"	8"	9"	10"	11"
JAN	-	-	-	-	-	-	-
FEB	-	-	-	-	-	-	-
MAR	2	-	-	-	-	-	-
APR	5	3	2	1	-	-	-
MAY	24	15	13	8	7	7	4
JUN	27	14	8	7	5	3	1
JUL	11	1	1	1	1	-	-
AUG	7	2	1	-	-	-	-
SEP	22	15	11	6	4	2	1
OCT	22	14	5	3	3	2	1
NOV	2	1	-	-	-	-	-
DEC	-	-	-	-	-	-	-

STRUCTURES MANAGED IN ROUTE SUBROUTINE

STRUCTURE PARAMETER	AUTHORIZED PROJECT	BASE CONDITION	ALTERNATIVE #1	ALTERNATIVE #2	ALTERNATIVE #3	ALTERNATIVE #4	ALTERNATIVE #5	ALTERNATIVE #6
STRUCTURE S-176								
Discharge	630 cfs	630 cfs	630 cfs	630 cfs	<100 cfs	Rating Curve	Rating Curve	Rating Curve
Headwater	6.0 ft	6.6 ft	6.0 ft	6.0 ft	6.0 ft			
Tailwater	5.5 ft	6.1 ft	5.5 ft	5.5 ft	5.9 ft			
Optimum	5.7 ft	5.7 ft	5.7 ft	5.7 ft	5.7 ft			
STRUCTURE S-174								
Discharge	500 cfs	500 cfs	1500 cfs	500 cfs	500 cfs	500 cfs	500 cfs	500 cfs
Headwater	6.0 ft	6.0 ft	6.0 ft	6.0 ft	6.0 ft	6.0 ft	6.0 ft	6.0 ft
Tailwater	5.5 ft	5.5 ft	5.5 ft	5.5 ft	5.5 ft	5.5 ft	5.5 ft	5.5 ft
Optimum	5.3 ft	5.3 ft	5.3 ft	5.3 ft	5.3 ft	5.3 ft	5.3 ft	5.3 ft
STRUCTURE S-175								
Discharge	500 cfs	500 cfs	500 cfs	500 cfs	---	500 cfs	---	500 cfs
Headwater	5.0 ft	5.0 ft	5.0 ft	3.5 ft	---	5.0 ft	---	5.0 ft
Tailwater	4.5 ft	4.5 ft	4.5 ft	3.0 ft	---	4.5 ft	---	4.5 ft
Optimum	4.5 ft	4.5 ft	4.5 ft	4.5 ft	---	4.5 ft	---	4.5 ft
PUMP STA. S-332								
Discharge	165 cfs	165 cfs	1000 cfs	---	---	165 cfs	---	165 cfs
Headwater	4.5 ft	4.5 ft	4.5 ft	---	---	4.5 ft	---	4.5 ft
Tailwater	4.5–5.5	4.5 ft	5.5 ft	---	---	5.5 ft	---	5.5 ft
Optimum	---	---	---	---	---	---	---	---

TABLE A-5

STRUCTURES MANAGED IN ROUTE SUBROUTINE

PUMP STA.	S-332A	At S-174						
PARAMETER	AUTHORIZED PROJECT	BASE CONDITION	ALTERNATIVE #1	ALTERNATIVE #2	ALTERNATIVE #3	ALTERNATIVE #4	ALTERNATIVE #5	ALTERNATIVE #6
Discharge	---	---	---	1000 cfs	1630 cfs	---	1000 cfs	---
Headwater	---	---	---	4.5 ft	5.5 FT	---	5.5 ft	---
Tailwater	---	---	---	5.5 ft	8.0 ft	---	8.0 ft	---
Optimum	---	---	---	---	---	---	---	---
PUMP STA.	S-332B	At Context Road						
Discharge	---	---	50 cfs	50 cfs	---	---	---	---
Headwater	---	---	---	---	---	---	---	---
Tailwater	---	---	8.5 ft	8.5 ft	---	---	---	---
Optimum	---	---	---	---	---	---	---	---
PUMP STA.	S-332B, C, E	At the Spreader Canal						
			C	C	B	E	B	E
Discharge	---	---	50 cfs	50 cfs	500 cfs	500 cfs	500 cfs	500 cfs
Headwater	---	---	3.0 ft	3.0 ft	3.0 ft	3.0 ft	3.0 ft	3.0 ft
Tailwater	---	---	4.0 ft	4.0 ft	4.0 ft	4.0 ft	4.0 ft	4.0 ft
Optimum	---	---	---	---	---	---	---	---
PUMP STA.	S-332A	At Rocky Glades						
Discharge	---	---	---	---	---	300 cfs	---	300 cfs
Headwater	---	---	---	---	---	5.5 ft	---	5.5 ft
Tailwater	---	---	---	---	---	8.0 ft	---	8.0 ft
Optimum	---	---	---	---	---	---	---	---

TABLE A-5
(Continued)

STRUCTURES MANAGED IN ROUTE SUBROUTINE

PARAMETER	AUTHORIZED PROJECT	BASE CONDITION	ALTERNATIVE #1	ALTERNATIVE #2	ALTERNATIVE #3	ALTERNATIVE #4	ALTERNATIVE #5	ALTERNATIVE #6
PUMP STA.	S-332B	At the west end of the northern connector canal from L-31N to NEW L-31W						
Discharge	---	---	---	---	---	300 cfs	---	300 cfs
Headwater	---	---	---	---	---	5.5 ft	---	5.5 ft
Tailwater	---	---	---	---	---	8.0 ft	---	8.0 ft
Optimum	---	---	---	---	---	---	---	---
PUMP STA.	S-332C	At the west end of the connector canal from L-31N to NEW L-31W, near C-103						
Discharge	---	---	---	---	---	300 cfs	---	300 cfs
Headwater	---	---	---	---	---	5.5 ft	---	5.5 ft
Tailwater	---	---	---	---	---	8.0 ft	---	8.0 ft
Optimum	---	---	---	---	---	---	---	---
PUMP STA.	S-332D	At the west end of the connector canal from S-174 to New L-31W						
Discharge	---	---	---	---	---	300 cfs	---	300 cfs
Headwater	---	---	---	---	---	5.5 ft	---	5.5 ft
Tailwater	---	---	---	---	---	8.0 ft	---	8.0 ft
Optimum	---	---	---	---	---	---	---	---
STRUCTURE	S-175A	At the north end of L-31W Extension						
Discharge	---	---	---	500 cfs	---	---	---	---
Headwater	---	---	---	4.5 ft	---	---	---	---
Tailwater	---	---	---	4.0 ft	---	---	---	---
Optimum	---	---	---	5.0 ft	---	---	---	---

TABLE A-5
(Continued)

C-111 ALTERNATIVES
PERCENT CHANCE EXCEEDANCE 1965-1989 SIMULATIONS
ELEVATIONS IN FEET NGVD

NODE	PLAN	10%	50%	90%	NODE	PLAN	10%	50%	90%
2 44	BASE	2.09	1.71	0.28	7 51	BASE	2.55	1.90	0.47
GRND	ALT 1	2.11	1.73	0.28	GRND	ALT 1	2.61	1.88	0.40
ELEV	ALT 2	2.13	1.74	0.25	ELEV	ALT 2	2.68	1.88	0.44
1.13	ALT 3	2.09	1.73	0.25	1.85	ALT 3	2.47	1.84	0.19
	ALT 4	2.11	1.73	0.26		ALT 4	2.48	1.83	0.19
	ALT 5	2.09	1.71	0.24		ALT 5	2.49	1.79	0.47
	ALT 6	2.10	1.73	0.27		ALT 6	2.61	1.86	0.52
4 43	BASE	2.43	1.86	0.38	7 55	BASE	2.39	1.72	0.23
GRND	ALT 1	2.45	1.88	0.38	GRND	ALT 1	2.29	1.47	0.08
ELEV	ALT 2	2.47	1.87	0.37	ELEV	ALT 2	2.29	1.48	0.13
1.52	ALT 3	2.43	1.86	0.36	0.83	ALT 3	2.12	1.45	-0.22
	ALT 4	2.45	1.87	0.39		ALT 4	1.95	1.37	-0.30
	ALT 5	2.42	1.84	0.36		ALT 5	1.95	1.33	0.12
	ALT 6	2.45	1.87	0.39		ALT 6	2.27	1.46	0.17
4 53	BASE	1.42	0.93	-0.43	8 44	BASE	2.96	2.27	1.03
GRND	ALT 1	1.42	0.92	-0.55	GRND	ALT 1	3.02	2.28	1.05
ELEV	ALT 2	1.44	0.95	-0.52	ELEV	ALT 2	3.09	2.26	1.02
0.20	ALT 3	1.49	0.93	-0.67	1.40	ALT 3	2.96	2.25	1.02
	ALT 4	1.45	0.91	-0.72		ALT 4	3.01	2.27	1.05
	ALT 5	1.45	0.92	-0.54		ALT 5	2.96	2.23	1.02
	ALT 6	1.41	0.90	-0.50		ALT 6	3.02	2.26	1.05
4 55	BASE	1.30	0.84	-0.35	8 47	BASE	3.08	2.42	0.89
GRND	ALT 1	1.36	0.86	-0.51	GRND	ALT 1	3.13	2.44	0.89
ELEV	ALT 2	1.37	0.88	-0.44	ELEV	ALT 2	3.25	2.39	0.84
0.05	ALT 3	1.37	0.83	-0.74	1.44	ALT 3	3.06	2.37	0.79
	ALT 4	1.34	0.75	-0.84		ALT 4	3.13	2.40	0.83
	ALT 5	1.39	0.89	-0.45		ALT 5	3.07	2.36	0.80
	ALT 6	1.35	0.85	-0.41		ALT 6	3.13	2.40	0.85
5 47	BASE	2.20	1.72	0.25	8 53	BASE	2.48	1.82	0.69
GRND	ALT 1	2.24	1.73	0.26	GRND	ALT 1	2.39	1.68	0.58
ELEV	ALT 2	2.30	1.72	0.23	ELEV	ALT 2	2.39	1.69	0.62
1.32	ALT 3	2.20	1.70	0.23	1.63	ALT 3	2.38	1.69	0.22
	ALT 4	2.23	1.71	0.26		ALT 4	2.20	1.66	0.18
	ALT 5	2.18	1.69	0.21		ALT 5	2.11	1.65	0.70
	ALT 6	2.22	1.71	0.27		ALT 6	2.37	1.67	0.69
5 50	BASE	1.78	1.24	-0.16	8 58	BASE	1.94	1.35	-0.03
GRND	ALT 1	1.79	1.25	-0.17	GRND	ALT 1	2.00	1.35	-0.08
ELEV	ALT 2	1.84	1.25	-0.19	ELEV	ALT 2	2.01	1.35	-0.06
1.05	ALT 3	1.85	1.22	-0.24	1.10	ALT 3	2.01	1.38	-0.15
	ALT 4	1.82	1.24	-0.23		ALT 4	1.95	1.34	-0.22
	ALT 5	1.78	1.23	-0.20		ALT 5	1.92	1.31	-0.12
	ALT 6	1.78	1.24	-0.17		ALT 6	2.00	1.34	-0.09
5 58	BASE	1.81	1.12	-0.09	8 61	BASE	1.50	1.06	-0.14
GRND	ALT 1	1.91	1.17	-0.14	GRND	ALT 1	1.51	1.08	-0.14
ELEV	ALT 2	1.92	1.18	-0.10	ELEV	ALT 2	1.52	1.08	-0.13
0.90	ALT 3	1.92	1.12	-0.42	1.00	ALT 3	1.52	1.09	-0.14
	ALT 4	1.84	1.04	-0.46		ALT 4	1.51	1.07	-0.18
	ALT 5	1.81	1.07	-0.18		ALT 5	1.51	1.06	-0.17
	ALT 6	1.90	1.15	-0.05		ALT 6	1.51	1.08	-0.15

TABLE A-6

C-111 ALTERNATIVES
PERCENT CHANCE EXCEEDANCE 1965-1989 SIMULATIONS
ELEVATIONS IN FEET NGVD

NODE	PLAN	10%	50%	90%	NODE	PLAN	10%	50%	90%
10 50	BASE	3.23	2.44	1.44	12 51	BASE	3.35	2.53	1.74
GRND	ALT 1	3.23	2.44	1.42	GRND	ALT 1	3.37	2.53	1.71
ELEV	ALT 2	3.47	2.42	1.41	ELEV	ALT 2	3.45	2.57	1.71
3.45	ALT 3	3.45	2.43	1.30	5.30	ALT 3	3.53	2.77	1.78
	ALT 4	3.21	2.43	1.40		ALT 4	3.39	2.63	1.77
	ALT 5	3.45	2.38	1.35		ALT 5	3.43	2.64	1.75
	ALT 6	3.22	2.42	1.44		ALT 6	3.34	2.53	1.74
10 55	BASE	2.46	1.81	0.52	13 47	BASE	4.40	4.14	2.42
GRND	ALT 1	2.47	1.82	0.55	GRND	ALT 1	4.83	4.19	2.44
ELEV	ALT 2	2.46	1.85	0.58	ELEV	ALT 2	4.48	3.63	2.17
1.65	ALT 3	2.78	2.10	0.51	3.95	ALT 3	4.69	3.92	2.25
	ALT 4	2.55	2.02	0.51		ALT 4	4.54	3.82	2.11
	ALT 5	2.44	1.81	0.60		ALT 5	4.46	3.81	2.11
	ALT 6	2.45	1.82	0.61		ALT 6	4.55	3.77	2.11
11 44	BASE	4.52	3.45	1.89	13 52	BASE	3.79	2.68	1.59
GRND	ALT 1	4.55	3.48	1.90	GRND	ALT 1	3.80	2.69	1.58
ELEV	ALT 2	4.54	3.44	1.86	ELEV	ALT 2	3.85	2.70	1.60
4.40	ALT 3	4.54	3.48	1.90	6.00	ALT 3	4.05	2.94	1.69
	ALT 4	4.54	3.47	1.91		ALT 4	3.81	2.77	1.69
	ALT 5	4.53	3.47	1.89		ALT 5	3.90	2.79	1.63
	ALT 6	4.54	3.47	1.90		ALT 6	3.74	2.69	1.62
11 47	BASE	3.61	2.70	1.75	13 55	BASE	3.84	2.22	0.82
GRND	ALT 1	3.72	2.72	1.76	GRND	ALT 1	3.86	2.20	0.84
ELEV	ALT 2	3.93	2.67	1.64	ELEV	ALT 2	3.88	2.22	0.86
1.95	ALT 3	3.63	2.64	1.65	3.80	ALT 3	4.05	2.43	0.88
	ALT 4	3.73	2.69	1.67		ALT 4	3.95	2.34	0.86
	ALT 5	3.65	2.61	1.58		ALT 5	3.90	2.22	0.88
	ALT 6	3.72	2.68	1.66		ALT 6	3.85	2.21	0.87
11 53	BASE	2.53	2.08	1.07	14 44	BASE	5.78	4.37	2.62
GRND	ALT 1	2.58	2.07	1.02	GRND	ALT 1	5.86	4.42	2.63
ELEV	ALT 2	2.59	2.09	1.06	ELEV	ALT 2	5.82	4.44	2.59
2.19	ALT 3	2.99	2.27	1.06	6.40	ALT 3	5.92	4.61	2.65
	ALT 4	2.74	2.23	1.06		ALT 4	5.89	4.54	2.61
	ALT 5	2.63	2.10	1.06		ALT 5	5.93	4.67	2.62
	ALT 6	2.57	2.07	1.07		ALT 6	5.89	4.53	2.60
11 58	BASE	2.51	1.62	0.11	14 58	BASE	2.85	1.61	0.37
GRND	ALT 1	2.49	1.62	0.15	GRND	ALT 1	2.85	1.60	0.37
ELEV	ALT 2	2.53	1.64	0.17	ELEV	ALT 2	2.86	1.62	0.38
2.20	ALT 3	2.65	1.83	0.19	2.80	ALT 3	2.90	1.71	0.42
	ALT 4	2.55	1.72	0.15		ALT 4	2.88	1.65	0.39
	ALT 5	2.52	1.63	0.16		ALT 5	2.87	1.61	0.38
	ALT 6	2.49	1.61	0.17		ALT 6	2.85	1.60	0.38
11 61	BASE	2.15	1.29	-0.27	14 61	BASE	2.22	1.14	0.00
GRND	ALT 1	2.16	1.29	-0.26	GRND	ALT 1	2.21	1.13	0.00
ELEV	ALT 2	2.19	1.30	-0.26	ELEV	ALT 2	2.21	1.14	0.00
1.50	ALT 3	2.25	1.32	-0.23	2.00	ALT 3	2.24	1.20	0.03
	ALT 4	2.21	1.29	-0.27		ALT 4	2.22	1.17	0.01
	ALT 5	2.19	1.27	-0.27		ALT 5	2.22	1.14	0.00
	ALT 6	2.16	1.29	-0.26		ALT 6	2.21	1.13	0.01

TABLE A-6
(Continued)

C-111 ALTERNATIVES PERCENT CHANCE EXCEEDANCE 1965-1989 SIMULATIONS ELEVATIONS IN FEET NGVD									
NODE	PLAN	10%	50%	90%	NODE	PLAN	10%	50%	90%
15 47	BASE	5.32	3.88	2.77	18 55	BASE	3.67	2.41	1.29
GRND	ALT 1	5.40	3.90	2.80	GRND	ALT 1	3.65	2.41	1.28
ELEV	ALT 2	5.44	4.30	2.67	ELEV	ALT 2	3.62	2.43	1.31
5.17	ALT 3	6.08	4.66	2.82	9.00	ALT 3	3.65	2.51	1.40
	ALT 4	5.78	4.40	2.55		ALT 4	3.61	2.47	1.40
	ALT 5	5.81	4.71	2.56		ALT 5	3.64	2.48	1.35
	ALT 6	5.77	4.39	2.54		ALT 6	3.60	2.44	1.33
15 49	BASE	5.08	3.75	2.38	19 47	BASE	6.16	4.85	3.21
GRND	ALT 1	5.10	3.77	2.38	GRND	ALT 1	6.24	4.90	3.21
ELEV	ALT 2	5.17	3.84	2.43	ELEV	ALT 2	6.19	5.00	3.28
5.50	ALT 3	6.65	4.25	2.43	5.71	ALT 3	6.32	5.14	3.31
	ALT 4	4.70	3.69	2.45		ALT 4	6.55	5.29	3.32
	ALT 5	5.52	4.12	2.34		ALT 5	6.60	5.42	3.26
	ALT 6	4.68	3.67	2.40		ALT 6	6.55	5.27	3.31
15 53	BASE	4.22	2.82	1.53	19 49	BASE	5.79	4.49	3.16
GRND	ALT 1	4.25	2.83	1.53	GRND	ALT 1	6.12	4.49	3.16
ELEV	ALT 2	4.26	2.87	1.55	ELEV	ALT 2	5.90	4.68	3.22
1.30	ALT 3	4.48	3.07	1.63	5.72	ALT 3	5.74	4.80	3.22
	ALT 4	4.22	2.89	1.62		ALT 4	5.56	4.86	3.29
	ALT 5	4.30	2.98	1.59		ALT 5	6.22	4.89	3.19
	ALT 6	4.18	2.83	1.59		ALT 6	5.55	4.83	3.27
16 51	BASE	4.80	3.49	2.16	19 50	BASE	5.69	4.57	3.26
GRND	ALT 1	4.82	3.51	2.15	GRND	ALT 1	5.68	4.57	3.26
ELEV	ALT 2	4.83	3.54	2.18	ELEV	ALT 2	5.35	4.61	3.27
7.20	ALT 3	5.18	3.83	2.23	6.75	ALT 3	5.42	4.76	3.29
	ALT 4	4.71	3.54	2.21		ALT 4	5.31	4.74	3.31
	ALT 5	4.95	3.73	2.19		ALT 5	5.48	4.81	3.27
	ALT 6	4.69	3.50	2.18		ALT 6	5.31	4.73	3.29
17 44	BASE	6.00	4.91	3.04	20 44	BASE	6.37	5.30	3.46
GRND	ALT 1	6.03	4.94	3.04	GRND	ALT 1	6.38	5.34	3.46
ELEV	ALT 2	6.06	5.02	3.04	ELEV	ALT 2	6.40	5.35	3.45
6.45	ALT 3	6.20	5.18	3.08	6.58	ALT 3	6.46	5.44	3.48
	ALT 4	6.25	5.21	3.08		ALT 4	6.60	5.59	3.49
	ALT 5	6.32	5.37	3.10		ALT 5	6.56	5.56	3.49
	ALT 6	6.25	5.20	3.07		ALT 6	6.60	5.57	3.49
17 47	BASE	5.76	4.31	2.94	20 54	BASE	4.30	3.05	1.85
GRND	ALT 1	5.79	4.34	2.95	GRND	ALT 1	4.27	3.06	1.83
ELEV	ALT 2	5.92	4.71	3.00	ELEV	ALT 2	4.19	3.03	1.86
5.65	ALT 3	6.28	4.95	3.02	10.00	ALT 3	4.21	3.07	2.13
	ALT 4	6.29	4.90	2.94		ALT 4	4.19	3.05	2.13
	ALT 5	6.65	5.28	2.95		ALT 5	4.20	3.07	1.90
	ALT 6	6.28	4.85	2.93		ALT 6	4.19	3.04	1.88
18 48	BASE	5.80	4.38	3.02	21 47	BASE	6.55	5.13	3.50
GRND	ALT 1	5.92	4.37	3.02	GRND	ALT 1	6.58	5.17	3.50
ELEV	ALT 2	6.00	4.69	3.09	ELEV	ALT 2	6.51	5.19	3.54
5.43	ALT 3	6.29	4.86	3.06	6.58	ALT 3	6.56	5.29	3.58
	ALT 4	6.40	4.86	3.12		ALT 4	6.96	5.48	3.60
	ALT 5	6.67	5.13	3.02		ALT 5	6.64	5.41	3.56
	ALT 6	6.40	4.85	3.10		ALT 6	6.96	5.46	3.57

TABLE A-6
(Continued)

C-111 ALTERNATIVES PERCENT CHANCE EXCEEDANCE 1965–1989 SIMULATIONS ELEVATIONS IN FEET NGVD									
NODE	PLAN	10%	50%	90%	NODE	PLAN	10%	50%	90%
21 49	BASE	5.90	4.67	3.33	18 52	BASE	4.78	3.62	2.13
GRND	ALT 1	5.87	4.67	3.32	GRND	ALT 1	4.77	3.62	2.12
ELEV	ALT 2	5.48	4.75	3.34	ELEV	ALT 2	4.72	3.68	2.15
6.29	ALT 3	5.51	4.86	3.37	8.75	ALT 3	4.80	3.86	2.21
	ALT 4	5.49	4.90	3.43		ALT 4	4.71	3.69	2.22
	ALT 5	5.60	4.90	3.35		ALT 5	4.77	3.82	2.16
	ALT 6	5.51	4.90	3.42		ALT 6	4.69	3.65	2.16
22 51	BASE	5.95	4.50	2.97	24 53	BASE	6.05	4.42	2.78
GRND	ALT 1	5.90	4.49	2.97	GRND	ALT 1	6.01	4.42	2.77
ELEV	ALT 2	5.58	4.51	2.98	ELEV	ALT 2	5.80	4.38	2.78
8.75	ALT 3	5.58	4.57	3.02	8.50	ALT 3	5.81	4.44	2.82
	ALT 4	5.64	4.61	3.02		ALT 4	5.87	4.48	2.82
	ALT 5	5.60	4.61	2.99		ALT 5	5.83	4.49	2.79
	ALT 6	5.60	4.58	2.99		ALT 6	5.83	4.47	2.79
23 49	BASE	6.05	4.78	3.43	22 56	BASE	5.78	3.30	1.61
GRND	ALT 1	6.01	4.78	3.42	GRND	ALT 1	5.78	3.27	1.61
ELEV	ALT 2	5.64	4.85	3.43	ELEV	ALT 2	5.72	3.26	1.62
6.30	ALT 3	5.64	4.96	3.47	8.00	ALT 3	5.71	3.31	1.76
	ALT 4	5.61	4.98	3.48		ALT 4	5.72	3.31	1.75
	ALT 5	5.70	5.01	3.45		ALT 5	5.73	3.28	1.68
	ALT 6	5.60	4.98	3.47		ALT 6	5.72	3.27	1.65
24 47	BASE	6.69	5.57	3.73	6 41	BASE	2.71	2.19	0.60
GRND	ALT 1	6.69	5.57	3.73	GRND	ALT 1	2.73	2.21	0.61
ELEV	ALT 2	6.65	5.56	3.74	ELEV	ALT 2	2.75	2.20	0.61
6.16	ALT 3	6.67	5.62	3.78	1.88	ALT 3	2.71	2.20	0.61
	ALT 4	7.10	5.98	3.79		ALT 4	2.73	2.20	0.63
	ALT 5	6.68	5.64	3.76		ALT 5	2.69	2.19	0.60
	ALT 6	7.10	5.97	3.76		ALT 6	2.73	2.20	0.62
26 50	BASE	6.87	5.37	3.77	13 41	BASE	5.55	4.12	2.25
GRND	ALT 1	6.86	5.37	3.76	GRND	ALT 1	5.56	4.15	2.25
ELEV	ALT 2	6.58	5.35	3.77	ELEV	ALT 2	5.56	4.15	2.26
6.85	ALT 3	6.56	5.40	3.79	5.50	ALT 3	5.57	4.19	2.31
	ALT 4	7.00	5.75	3.82		ALT 4	5.57	4.18	2.31
	ALT 5	6.59	5.42	3.79		ALT 5	5.57	4.22	2.32
	ALT 6	7.00	5.73	3.81		ALT 6	5.57	4.18	2.30
29 52	BASE	6.20	5.37	4.10					
GRND	ALT 1	6.21	5.37	4.09					
ELEV	ALT 2	6.20	5.34	4.10					
6.78	ALT 3	6.20	5.35	4.13					
	ALT 4	6.03	5.22	4.13					
	ALT 5	6.20	5.35	4.10					
	ALT 6	6.02	5.22	4.11					
32 51	BASE	7.20	6.63	5.03					
GRND	ALT 1	7.21	6.63	5.03					
ELEV	ALT 2	7.21	6.63	5.04					
5.92	ALT 3	7.21	6.63	5.10					
	ALT 4	7.25	6.64	5.11					
	ALT 5	7.21	6.63	5.06					
	ALT 6	7.25	6.64	5.05					

TABLE A–6
(Continued)

C-111 ALTERNATIVES
FLOOD EVENT PEAK STAGES vs. EXCEEDANCE FREQUENCY
ELEVATIONS IN FEET NGVD

NODE	PLAN	50%	10%	2%	SPF	NODE	PLAN	50%	10%	2%	SPF
14 51	BASE	5.59	6.00	6.53	6.95	15 49	BASE	5.68	6.17	6.51	7.20
GRND	ALT 1	5.60	5.97	6.48	6.93	GRND	ALT 1	5.88	6.31	6.63	7.24
ELEV	ALT 2	5.61	5.99	6.40	6.94	ELEV	ALT 2	6.01	6.42	6.77	7.39
5.50	ALT 3	5.68	6.12	6.65	7.32	5.50	ALT 3	8.07	9.07	9.82	10.68
	ALT 4	5.56	6.07	6.69	7.12		ALT 4	[illegible]	5.53	5.86	6.72
	ALT 5	5.62	5.99	6.41	6.95		ALT 5	5.98	6.34	6.71	7.35
	ALT 6	5.55	5.94	6.45	6.85		ALT 6	5.24	5.52	5.69	6.48
16 51	BASE	5.90	6.64	7.22	7.63	12 53	BASE	3.85	3.95	4.09	4.63
GRND	ALT 1	5.93	6.64	7.23	7.62	GRND	ALT 1	3.86	3.94	4.23	4.82
ELEV	ALT 2	5.93	6.64	7.23	7.62	ELEV	ALT 2	3.86	3.94	4.24	4.82
7.20	ALT 3	6.24	7.08	7.32	7.82	3.80	ALT 3	4.25	4.80	5.26	5.97
	ALT 4	5.83	6.59	7.23	7.64		ALT 4	3.89	4.58	5.05	5.79
	ALT 5	6.00	6.72	7.26	7.65		ALT 5	3.89	4.34	4.77	5.39
	ALT 6	5.81	6.53	7.20	7.55		ALT 6	3.86	3.95	4.21	4.80
19 51	BASE	6.20	6.49	7.09	7.93	17 53	BASE	5.94	7.06	7.77	8.33
GRND	ALT 1	6.16	6.39	6.87	7.84	GRND	ALT 1	5.95	7.07	7.77	8.32
ELEV	ALT 2	6.03	[illegible]	6.76	7.82	ELEV	ALT 2	5.94	7.05	7.77	8.32
7.80	ALT 3	5.97	[illegible]	6.86	7.74	7.50	ALT 3	6.05	7.30	7.82	8.38
	ALT 4	6.05	6.36	6.85	7.86		ALT 4	5.89	7.01	7.76	8.32
	ALT 5	6.06	6.40	6.83	7.87		ALT 5	5.97	7.11	7.78	8.34
	ALT 6	6.03	6.32	6.73	7.82		ALT 6	5.87	6.97	7.75	8.29
21 51	BASE	6.72	7.20	7.58	8.27	19 53	BASE	5.36	5.82	6.26	6.98
GRND	ALT 1	6.68	7.12	7.49	7.98	GRND	ALT 1	5.33	5.77	6.16	6.88
ELEV	ALT 2	6.45	6.97	7.46	7.93	ELEV	ALT 2	5.22	5.69	6.11	6.81
7.50	ALT 3	6.38	6.89	7.39	7.88	10.00	ALT 3	5.24	5.76	6.30	7.08
	ALT 4	6.47	6.97	7.51	8.02		ALT 4	5.23	5.72	6.26	7.06
	ALT 5	6.47	6.98	7.50	8.08		ALT 5	5.26	5.72	6.14	6.86
	ALT 6	6.47	6.97	7.45	7.98		ALT 6	5.22	5.68	6.09	6.77
23 51	BASE	7.73	8.04	8.38	8.90	22 53	BASE	7.41	8.76	9.10	9.56
GRND	ALT 1	7.70	8.03	8.33	8.74	GRND	ALT 1	7.38	8.73	9.08	9.52
ELEV	ALT 2	7.63	7.98	8.28	8.74	ELEV	ALT 2	7.15	8.60	9.02	9.49
7.50	ALT 3	7.61	7.97	8.28	8.70	8.75	ALT 3	7.14	8.60	9.02	9.48
	ALT 4	7.64	7.99	8.30	8.78		ALT 4	7.16	8.61	9.02	9.49
	ALT 5	7.62	7.98	8.30	8.81		ALT 5	7.14	8.59	9.01	9.49
	ALT 6	7.64	7.99	8.30	8.75		ALT 6	7.15	8.60	9.02	9.49

TABLE A-7

TABLE A-8
Optimum Stages in ENP-South Dade Conveyance System

Canal	Reach	Elevation
Levee 29 Borrow Canal	S-333 to S-334	5.0
Levee 30 Borrow Canal	S-32A to S-335	6.0
Levee 30 Borrow Canal	S-335 to U.S. 41	5.0
Levee 31(N) Borrow Canal	U.S. 41 to S-331	5.0
Levee 31(N) Rem. Borrow Canal	S-331 to S-176	5.5
Canal 111	S-176 to S-177	4.5
Canal 111	S-177 to S-18C	2.0
Levee 31(W) Borrow Canal	S-174 to S-175	4.5
Canal 103	L-31(N) Rem. to S-167	5.5
Canal 103	S-167 to S-179	3.5
Canal 103	S-179 to S-20F	2.0
Canal 102	L-31(N) Rem to S-165	5.5
Canal 102	S-165 to S-21A	2.0
Canal 1	L-31(N) to S-148	5.0
Canal 1	S-148 to S-21	2.0

TABLE A-9
Minimum Monthly Delivery Schedule to Taylor Slough at S-332

	Percent of Annual Flow	Monthly Flow Acre-Feet	Average Daily Flow Cubic Feet per Second
Jan	2.0	740	12.0
Feb	1.0	370	6.7
Mar	0.5	185	3.0
Apr	0.5	185	3.1
May	1.0	370	6.0
Jun	18.0	6,600	112.0
Jul	20.0	7,400	120.0
Aug	8.0	2,960	48.0
Sep	16.0	5,920	100.0
Oct	21.0	7,770	126.0
Nov	10.0	3,700	62.0
Dec	2.0	740	12.0
Total	100.0	37,000	

Note: All elevations are in feet, NGVD

TABLE A-10
Minimum Monthly Delivery Schedule to Eastern Panhandle
As delivered at S-18C

Month	Acre-Feet
Jan	1,540
Feb	630
Mar	290
Apr	110
May	110
Jun	340
Jul	510
Aug	860
Sep	2,690
Oct	4,630
Nov	4,060
Dec	2,230

TABLE A-11
Hydraulic Design Data
Pump Station S-332A

Total Discharge	300 cfs
Number of pumps	4
Pump No. 1 discharge	75 cfs
Pump No. 2 discharge	75 cfs
Pump No. 3 discharge	75 cfs
Pump No. 4 discharge	75 cfs
Intake Water Surface Elevation	
Maximum Pumping	8.8 ft
Maximum Non-Pumping	5.7 ft
Start Pumping	5.7 ft
Normal Drawdown Pumping	5.7 ft
Minimum Non-Pumping	2.0 ft
Discharge Water Surface Elevation	
Maximum Pumping	10.3 ft
Normal Pumping	8.0 ft
Minimum Pumping	6.0 ft
Minimum Non-Pumping	5.0 ft

Note: All elevations are in feet, NGVD

TABLE A-12
Hydraulic Design Data
Pump Station S-332B

Total Discharge	300 cfs
Number of pumps	4
Pump No. 1 discharge	75 cfs
Pump No. 2 discharge	75 cfs
Pump No. 3 discharge	75 cfs
Pump No. 4 discharge	75 cfs
Intake Water Surface Elevation	
Maximum Pumping	6.5 ft
Maximum Non-Pumping	6.5 ft
Start Pumping	3.0 to 6.5 ft
Normal Drawdown Pumping	4.0 ft
Minimum Non-Pumping	3.0 ft
Discharge Water Surface Elevation	
Maximum Pumping	10.3 ft
Normal Pumping	8.0 ft
Minimum Pumping	6.0 ft
Minimum Non-Pumping	5.0 ft

TABLE A-13
Hydraulic Design Data
Pump Station S-332C

Total Discharge	300 cfs
Number of pumps	4
Pump No. 1 discharge	75 cfs
Pump No. 2 discharge	75 cfs
Pump No. 3 discharge	75 cfs
Pump No. 4 discharge	75 cfs
Intake Water Surface Elevation	
Maximum Pumping	6.5 ft
Maximum Non-Pumping	6.5 ft
Start Pumping	3.0 to 6.5 ft
Normal Drawdown Pumping	4.0 ft
Minimum Non-Pumping	3.0 ft
Discharge Water Surface Elevation	
Maximum Pumping	9.8 ft
Normal Pumping	8.0 ft
Minimum Pumping	6.0 ft
Minimum Non-Pumping	4.5 ft

Note: All elevations are in feet, NGVD

TABLE A-14
Hydraulic Design Data
Pump Station S-332D

Total Discharge	300 cfs
Number of pumps	4
Pump No. 1 discharge	75 cfs
Pump No. 2 discharge	75 cfs
Pump No. 3 discharge	75 cfs
Pump No. 4 discharge	75 cfs
Intake Water Surface Elevation	
Maximum Pumping	6.5 ft
Maximum Non-Pumping	6.5 ft
Start Pumping	3.0 to 6.5 ft
Normal Drawdown Pumping	4.0 ft
Minimum Non-Pumping	3.0 ft
Discharge Water Surface Elevation	
Maximum Pumping	9.3 ft
Normal Pumping	8.0 ft
Minimum Pumping	6.0 ft
Minimum Non-Pumping	4.5 ft

TABLE A-15
Hydraulic Design Data
Pump Station S-332E

Total Discharge	50 cfs
Number of pumps	1
Intake Water Surface Elevation	
Maximum Pumping	5.0 ft
Maximum Non-Pumping	5.0 ft
Start Pumping	2.5 to 3.5 ft
Normal Drawdown Pumping	3.5 ft
Minimum Non-Pumping	2.0 ft
Discharge Water Surface Elevation	
Maximum Pumping	5.0 ft
Normal Pumping	4.5 ft
Minimum Pumping	4.0 ft
Minimum Non-Pumping	2.0 ft
Tieback levee	
Crest Elevation at Pump Station	6.3 ft
Width of Levee Crest	10.0 ft
Side Slope 1 on	3
Natural Grade, at the Pump	3.5 ft

Note: All elevations are in feet, NGVD

TABLE A-16
Hydraulic Design Data
C-111 North

Comments	Station (ft)	Discharge (cfs)	W.S. Elev. (ft, NGVD)	Btm. Width (ft)	Invert (ft, NGVD)	Side Slope 1 on
at S-178	0+00	50.0	4.00	15	-1.2	1
Intake at S-332E	2+00	50.0	4.00	15	-1.2	1
Discharge at S-332E	2+50	50.0	4.50	15	-1.2	1
	26+50	50.0	4.37	15	-1.2	1
	101+70	25.0	4.25	10	-1.2	1
	101+71	25.0	4.25	10	-0.625	1
	152+55	12.5	4.13	10	-0.625	1
End of Channel	203+40	0.0	4.00	10	-0.625	1

TABLE A-17
Hydraulic Design Data
L-31W Tieback
LOCATED ABOUT 1 MILE WEST OF L-31N, RUNNING NORTH TO SOUTH

LOCATION	STATION	TOP ELEVATION	EXISTING GROUND
NEAR S-332B	0+00	10.5	7.0
NEAR S-332C	55+00	9.8	6.5
NEAR S-332D (TIE-INTO NORTH END OF EXISTING L-31W)	187+00	9.3	6.5
TIE-INTO SOUTH END OF EXISTING L-31W	277+00	9.0	6.0
NEAR S-175	435+00	9.0	5.0
C-111	488+00	7.0	5.5

TABLE A-18
Hydraulic Design Data
S-332D Tieback
LOCATED ABOUT 0.5 MILE WEST OF L-31N, RUNNING NORTH TO SOUTH

LOCATION	STATION	TOP ELEVATION	GROUND ELEVATION
NEAR S-332A	0+00	10.5	7.5
NEAR S-332B	190+00	10.5	7.0
NEAR S-332C	296+00	9.8	6.5
L-31W	428+00	9.3	6.5
TIE-INTO EXISTING L-31N	450+00	9.3	6.5

Note: All elevations are in feet, NGVD

TABLE A-19
Hydraulic Design Data
Retention/Detention Area Culverts

Design Conditions	
Discharge	17.3 cfs
Headwater Elevation	8.3 ft varies
Tailwater Elevation	7.8 ft varies
Optimum Conditions	
Headwater Elevation	7.0 ft
Tailwater Elevation	6.5 ft
Culvert Size	
Number of Pipes	1
Diameter (CMP)	36 inches
Invert Elevation	3.5 ft
Length	50 ft
Riser Diameter	48 inches
Type of Control	Stop Log

TABLE A-20
Hydraulic Design Data
Culvert from C-111 connector canal to S-332

Design Conditions	
Discharge	165 cfs
Headwater Elevation	5.5 ft
Tailwater Elevation	5.0 ft
Optimum Conditions	
Headwater Elevation	4.5 ft
Tailwater Elevation	4.5 ft
Culvert Size	
Number of Pipes	3
Diameter (CMP)	84 inches
Invert Elevation	-3.0 ft
Length	66 ft
Type of Control	flap-gate

Note: All elevations are in feet, NGVD

TABLE A-21
Hydraulic Design Data
Existing Channel Dimensions

Location	Station (ft)	Invert (ft, NGVD)	Btm. Width (ft)
C-111			
Structure S-18C	481+70	-12.0	100
Junction C-111E	481+70 to 594+94 (STA. 0+00)	-12.0	100
Structure S-177	594+94 to 791+00	-10.0	70
Structure S-176	793+67 to 1080+34	-12.0	40
C-111E			
From Junction C-111E	0+00 to 60+00	-12.0	20
	60+00 to 120+00	-12.0	20
To Structure S-178	1[illegible]+00 to 180+00	-9.0	20
L-31N Borrow Canal			
From Junction C-111	532+00	-12.0	35
Junction C-103	532+00 to 720+00	-12.0	35
Junction C-102	720+00 to 980+00	-10.0	20
To Junction S-173 (S-331)	980+00 to 1113+34	-3.5	10

TABLE A-22
Existing Structure Hydraulic Data

Item Type	S-174 Gated Spillway	S-175 Gated Culvert	S-176 Gated Spillway	S-177 Gated Spillway	S-18C Gated Spillway	S-197 Gated Culvert	S-332 Pump Station
Design Condition							
Discharge (cfs)	500.0	500.0	630.0	1400.0	2100.0	2400.0	Varies 5.0 to 165
Headwater Elev.	6.0	5.0	6.0	4.3	2.6	1.4	3.0
Tailwater Elev.	5.5	4.5	5.5	3.7	2.1	0.6	Below 5.8
Optimum Condition							
Headwater Elev.	4.3 to 4.8	4.5	4.3 to 4.8	3.9	None	None	
Tailwater Elev.	None	None	None	None	Tidal	None	
SPF Condition (est.)							
Discharge (cfs)	850.0	500.0	1100.0	2900.0	3200.0	None	
Headwater Elev.	7.5	6.0	7.5	6.0	3.8	None	
Tailwater Elev.	6.5	5.5	6.3	4.0	2.8	None	
Minimum Condition (est.)							
Headwater Elev.	3.0	2.0	3.0	2.0	1.0	-0.5	
Tailwater Elev.	2.0	-1.0	2.0	1.0	-2.0	-1.0	
Gates							
Number	1.0	3.0	1.0	1.0	2.0	10.0	6.0
Width by Height (ft)	16.0 x 8.0	84" dia	20.0 x 8.5	22.0 x 12.6	22.0 x 11.0	4.0 x 12.0	
Type of Controls	Auto. Vertical Lif	Manual Slide Gate	Auto. Vertical Lif	Auto. Vertical Lift	Vert. lift w/ Slide Gat	Manual Slide Gal	Flapgates
Apron							
Elevation	-3.5		-2.0	-8.0	-8.0		
Length	20.0		20	20	20		
End Sill Elev.	-2.5		-1.0	-7.0	-7.0		
Culvert Type		CMP					
Number/Size of Barrels		3 - 84"				13 - 84"	
Invert Elev.							

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Appendix A

Hydrology and Hydraulic Analysis

PHOTOGRAPHS

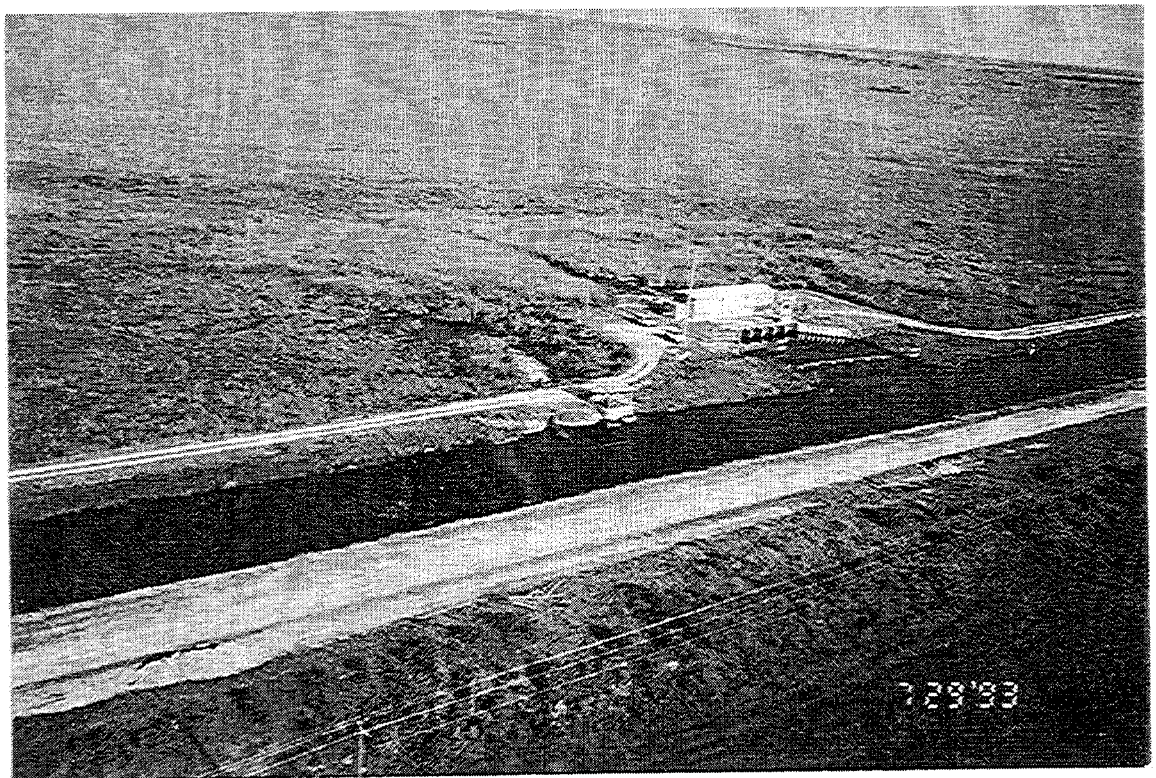

PHOTO A-1. AERIAL VIEW OF PUMP STATION S-332 ON L-31W BORROW CANAL. TAYLOR SLOUGH FLOWS RIGHT TO LEFT ACROSS THE MIDDLE OF THIS VIEW.

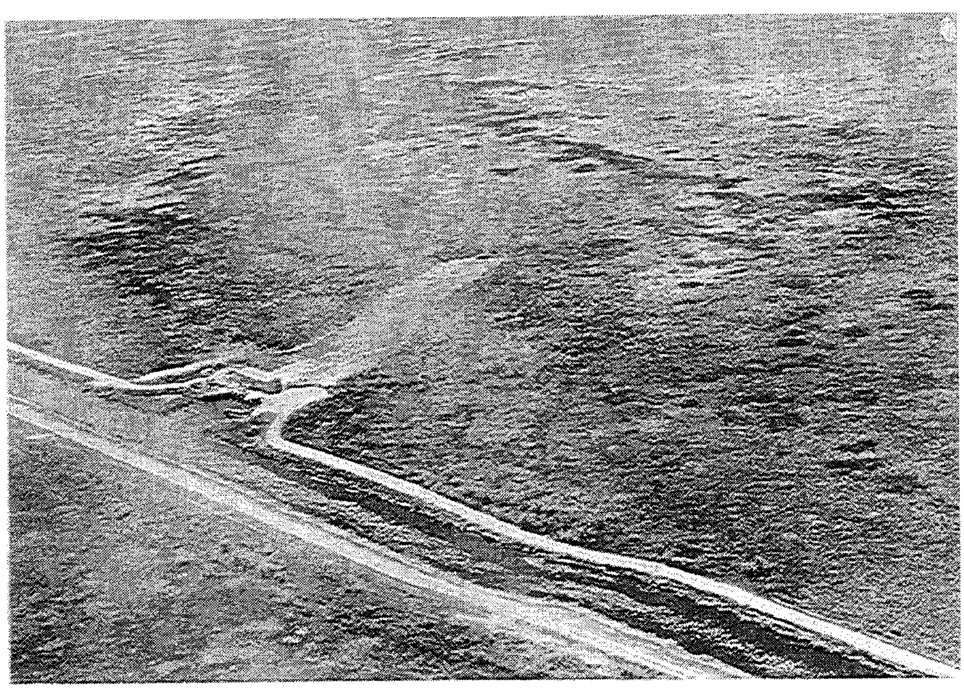

PHOTO A-2. AERIAL VIEW OF PUMP STATION S-332 ON L-31W BORROW CANAL. MORE RECENT PHOTO SHOWS ADDITIONAL PUMP INTAKE ON NORTH SIDE OF INTAKE. TAYLOR SLOUGH FLOWS RIGHT TO LEFT ACROSS THE MIDDLE/TOP OF THIS VIEW.

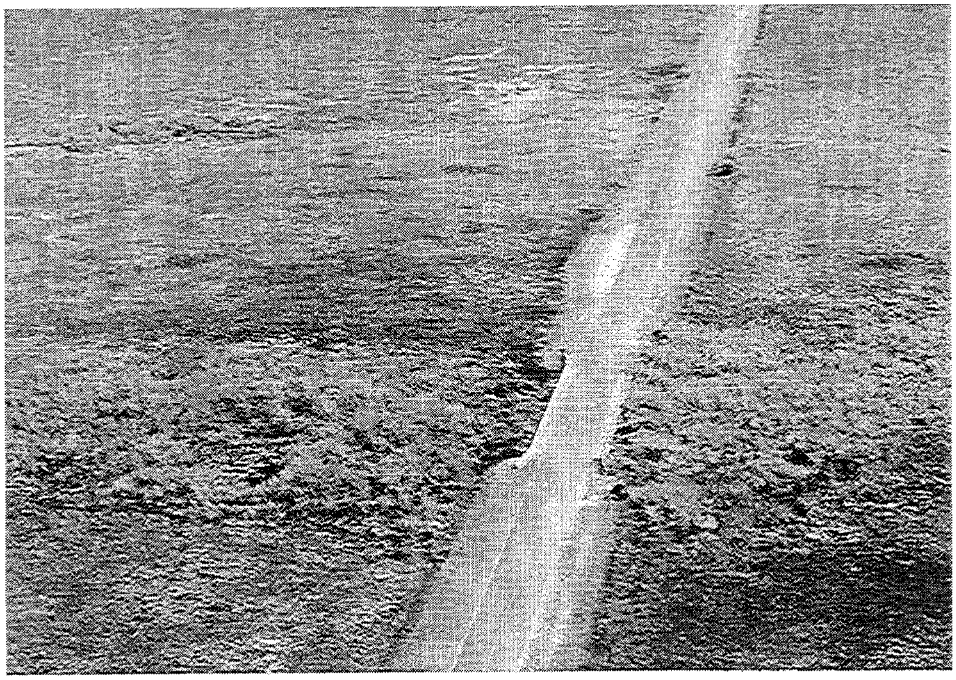

PHOTO A-3. LOOKING EASTERLY AT TAYLOR SLOUGH, WITH STATE ROAD 9336 (FORMERLY SR 27) AND SHALLOW BOX CULVERT TYPE BRIDGE, 60 FEET LONG.

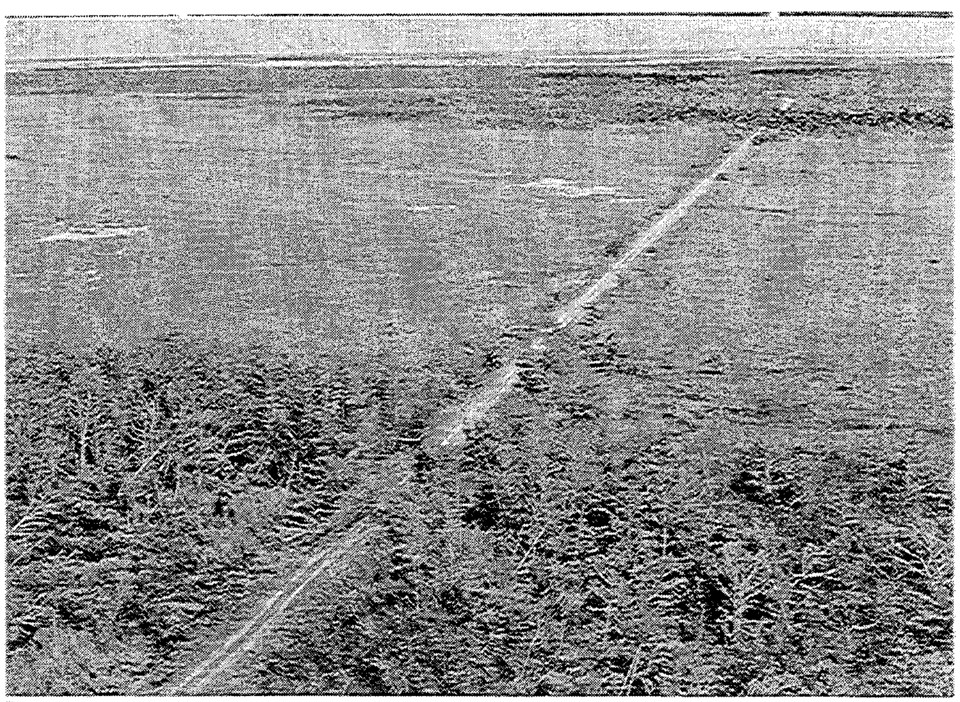

PHOTO A-4. AERIAL VIEW LOOKING EAST AT OLD INGRAHAM HIGHWAY. AN UNPAVED ROAD THAT WAS THE ORIGINAL ACCESS IN TO THE AREA, IT WAS BUILT IN 1916. IT CROSSES TAYLOR SLOUGH WHICH FLOWS FROM LEFT TO RIGHT IN THIS VIEW.

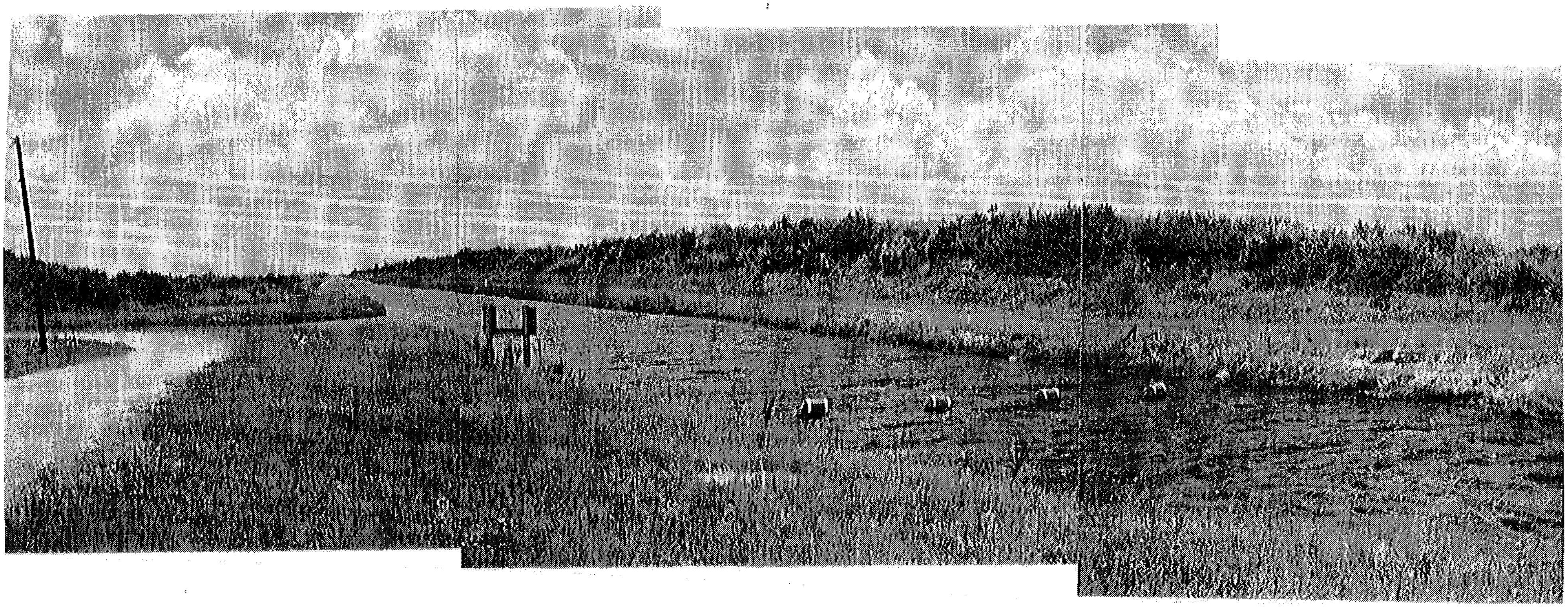

PHOTO A-5. LOOKING NORTH ALONG L-31N BORROW CANAL, JUST UPSTREAM OF S-176. THE JUNCTION WITH L-31W BORROW CANAL CAN BE SEEN AT LEFT, S-174 IS OUT OF FRAME TO THE LEFT.

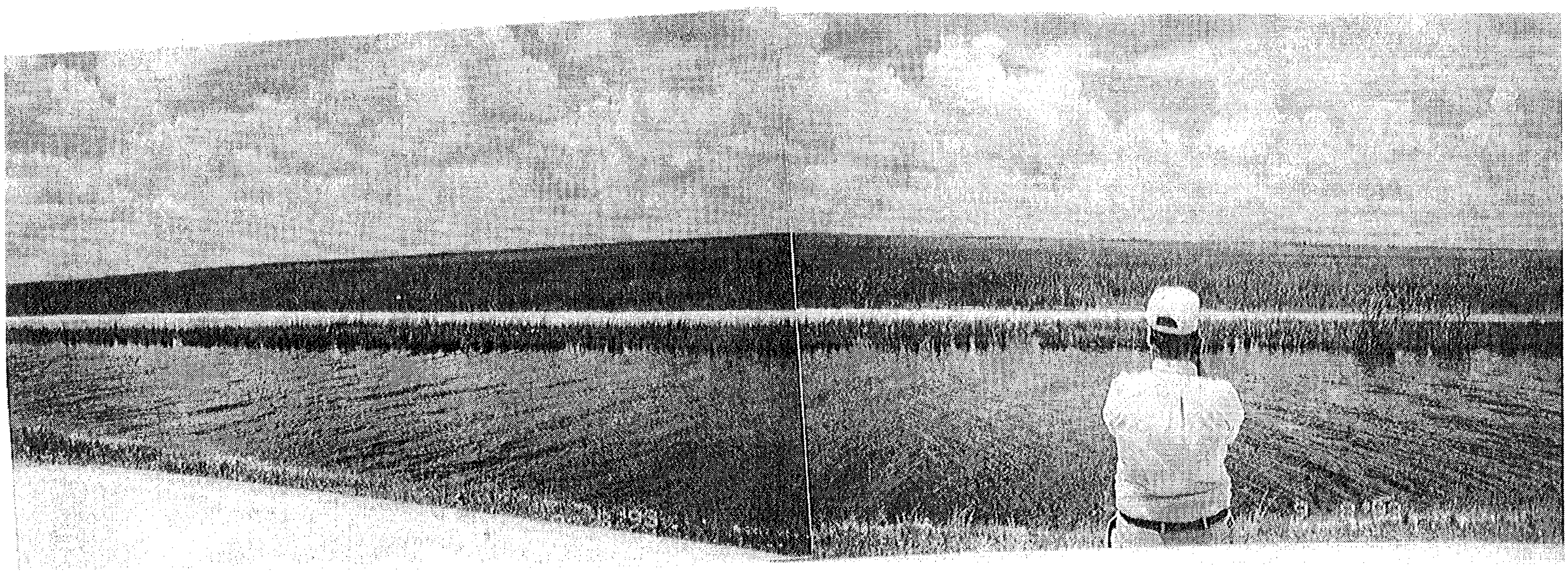

PHOTO A-6 LOOKING WEST ACROSS L-31W BORROW CANAL INTO EVERGLADES NATIONAL PARK, ABOUT 2000 FEET NORTH OF PUMP STATION S-332.

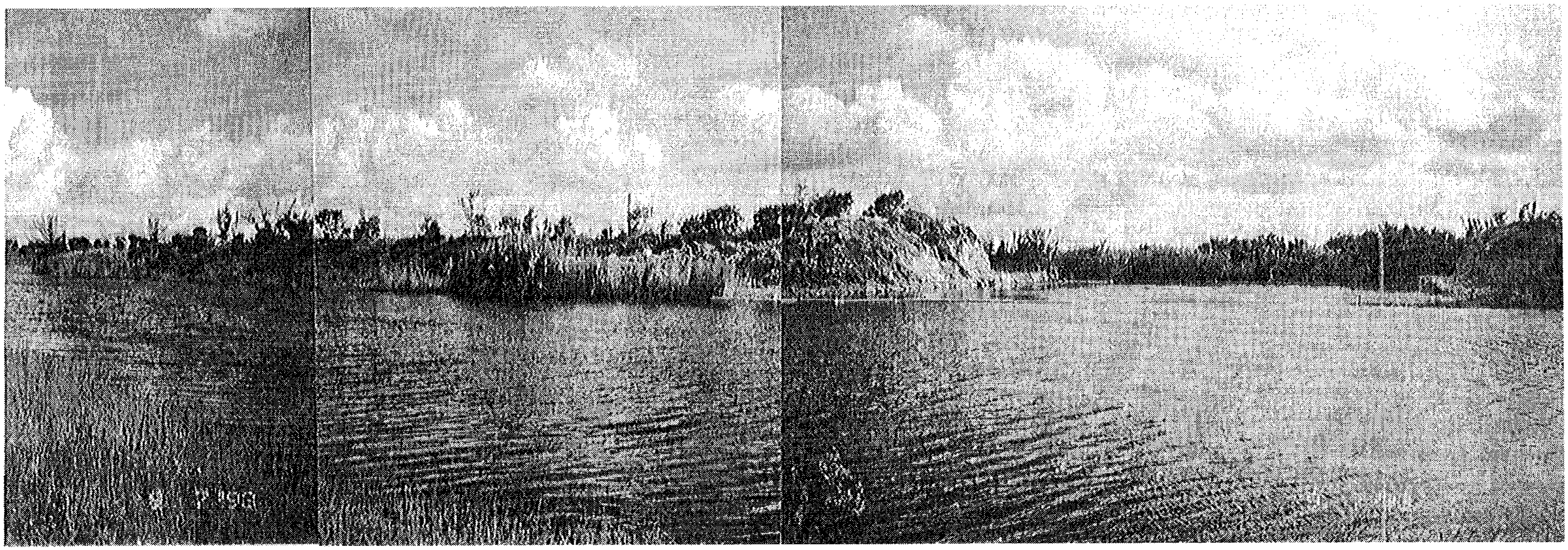

PHOTO A-7. LOOKING EAST ALONG THE SOUTHERN LEG OF C-111, WITH THE SPOIL MOUNDS ON THE SOUTHERN BANK ON THE RIGHT. NOTE THE RECENTLY CLEANED OUT GAP AT FAR RIGHT, THAT WILL ALLOW OVERLAND FLOW TOWARD THE EASTERN PANHANDLE OF EVERGLADES NATIONAL PARK.

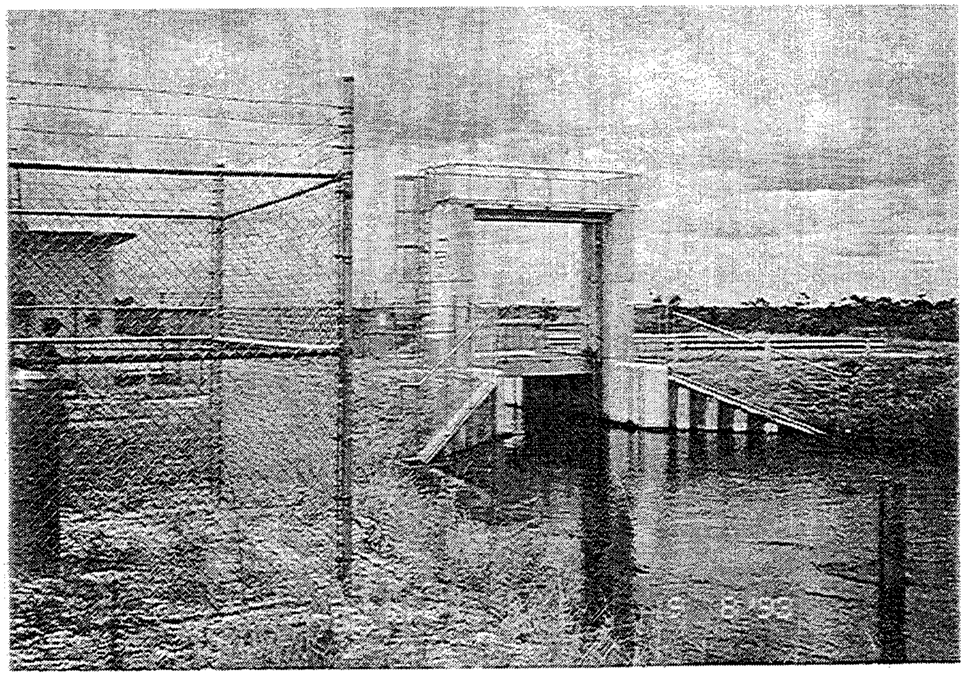

PHOTO A-8. LOOKING WEST AT S-174, ON L-31W.

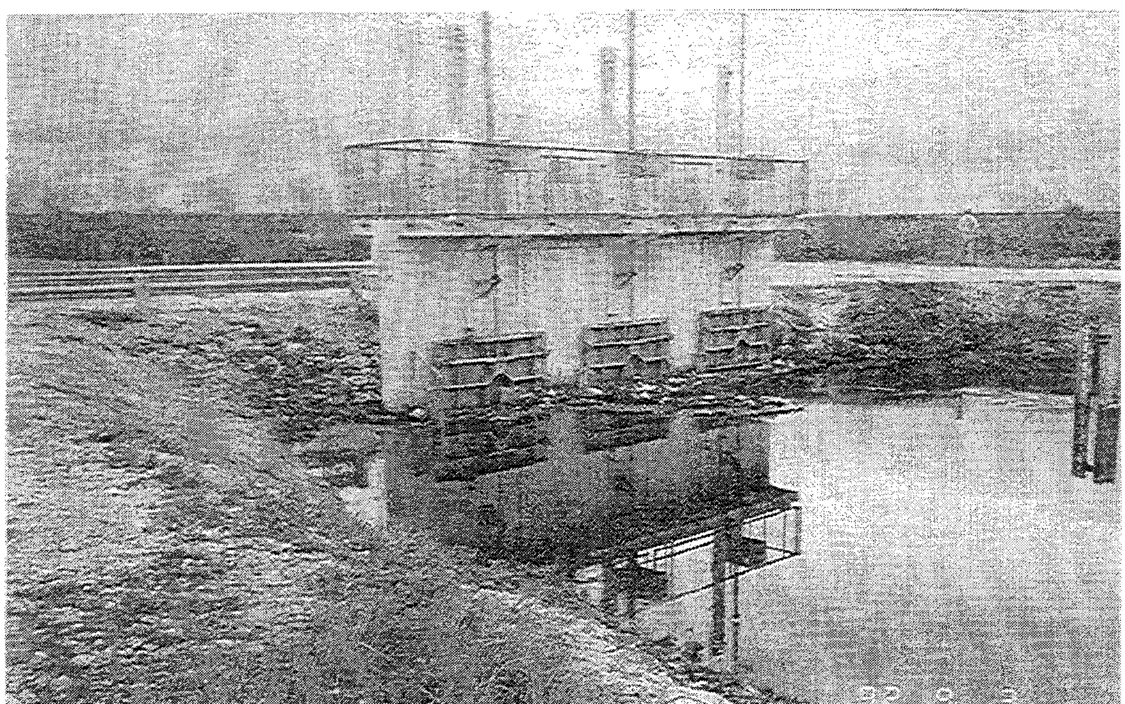

PHOTO A-9. LOOKING AT THE UPSTREAM SIDE OF S-175 ON L-31W.

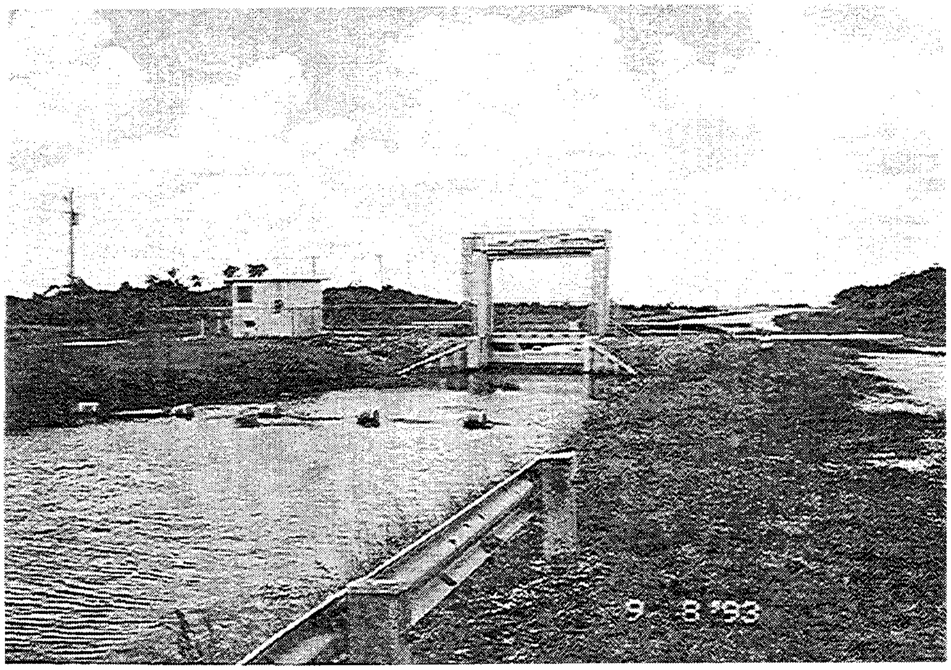

PHOTO A-10. LOOKING SOUTH AT S-176, WHERE THE "CANAL" CHANGES NAME FROM L-31N BORROW CANAL UPSTREAM TO C-111 DOWNSTREAM OF S-176.

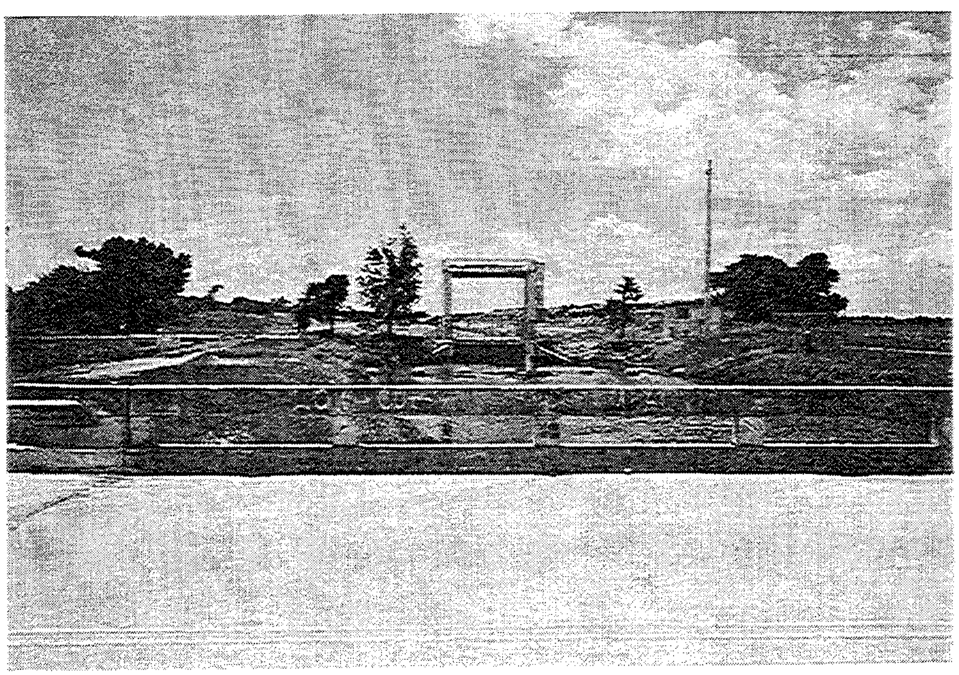

PHOTO A-11. LOOKING DOWNSTREAM AT S-177, ON C-111.

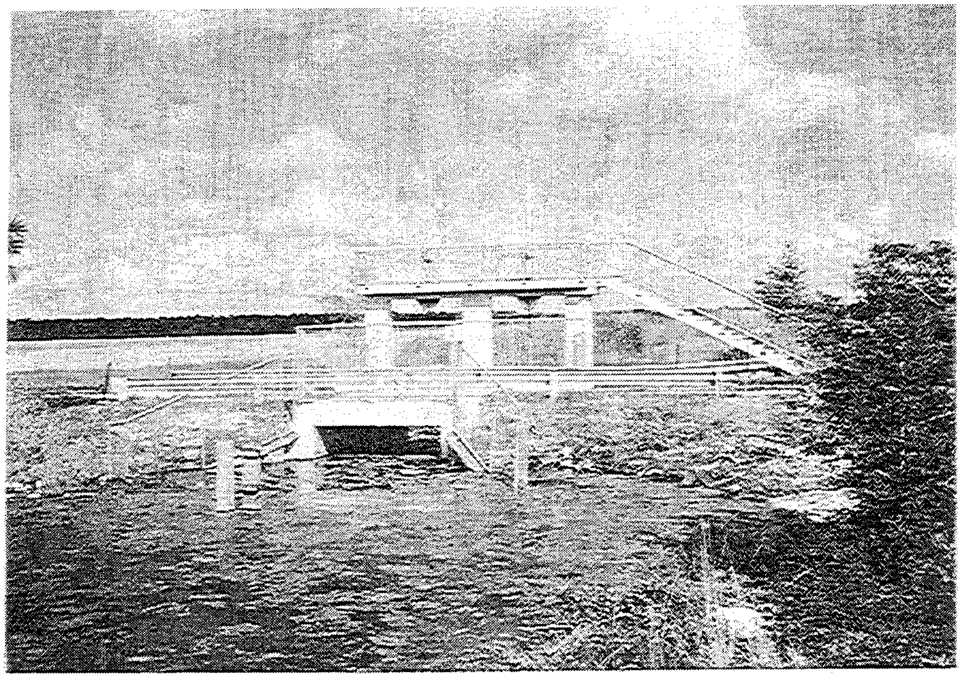

PHOTO A-12. LOOKING UPSTREAM AT S-178 ON C-111E.

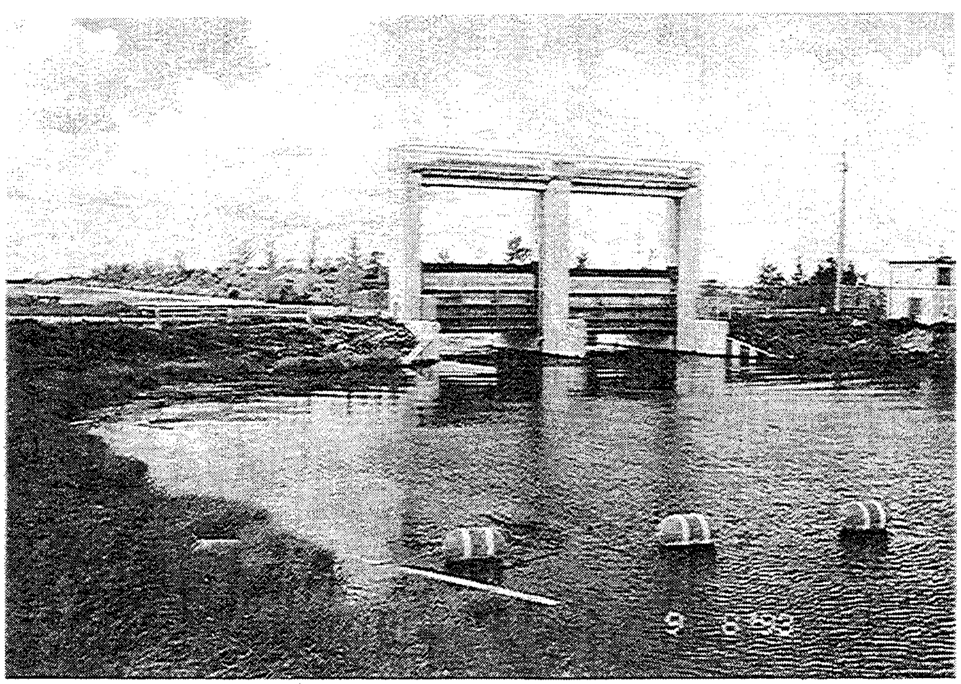

PHOTO A-13. LOOKING DOWNSTREAM AT S-18C ON C-111.

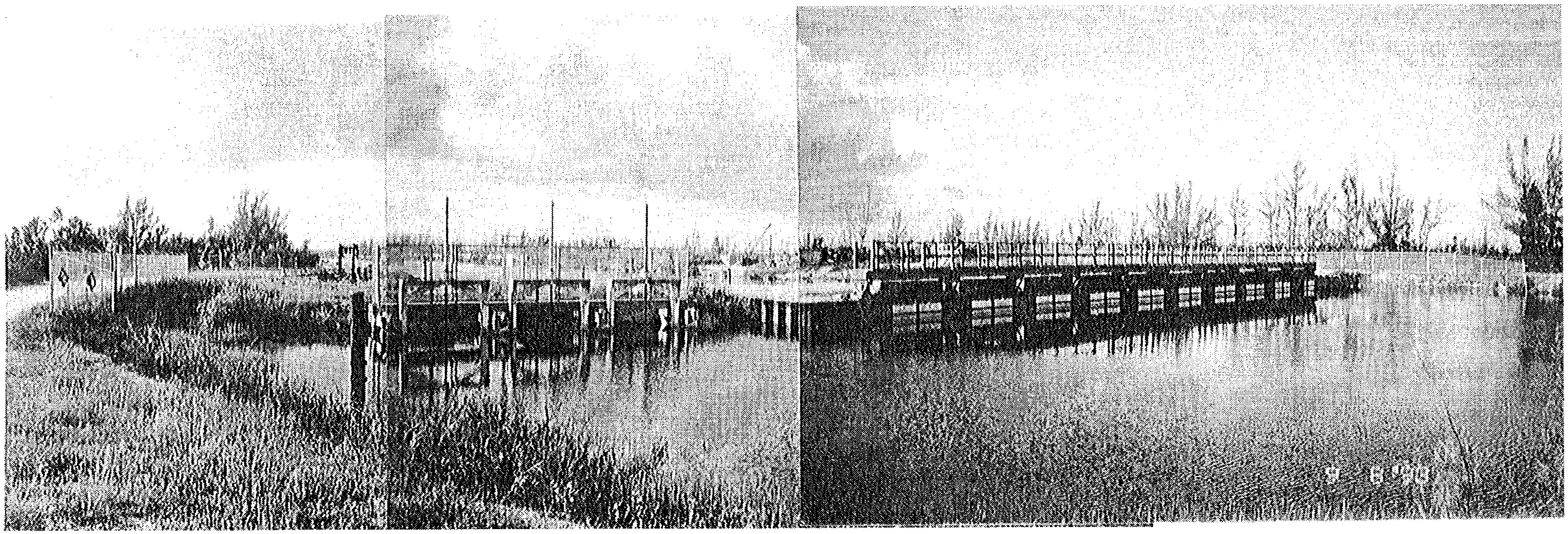

PHOTO A-14. LOOKING AT THE UPSTREAM SIDE OF S-197, THE THREE ORIGINAL CULVERTS AT LEFT, AND THE TEN ADDITIONAL INSTALLED BY THE LOCAL SPONSOR AT RIGHT.

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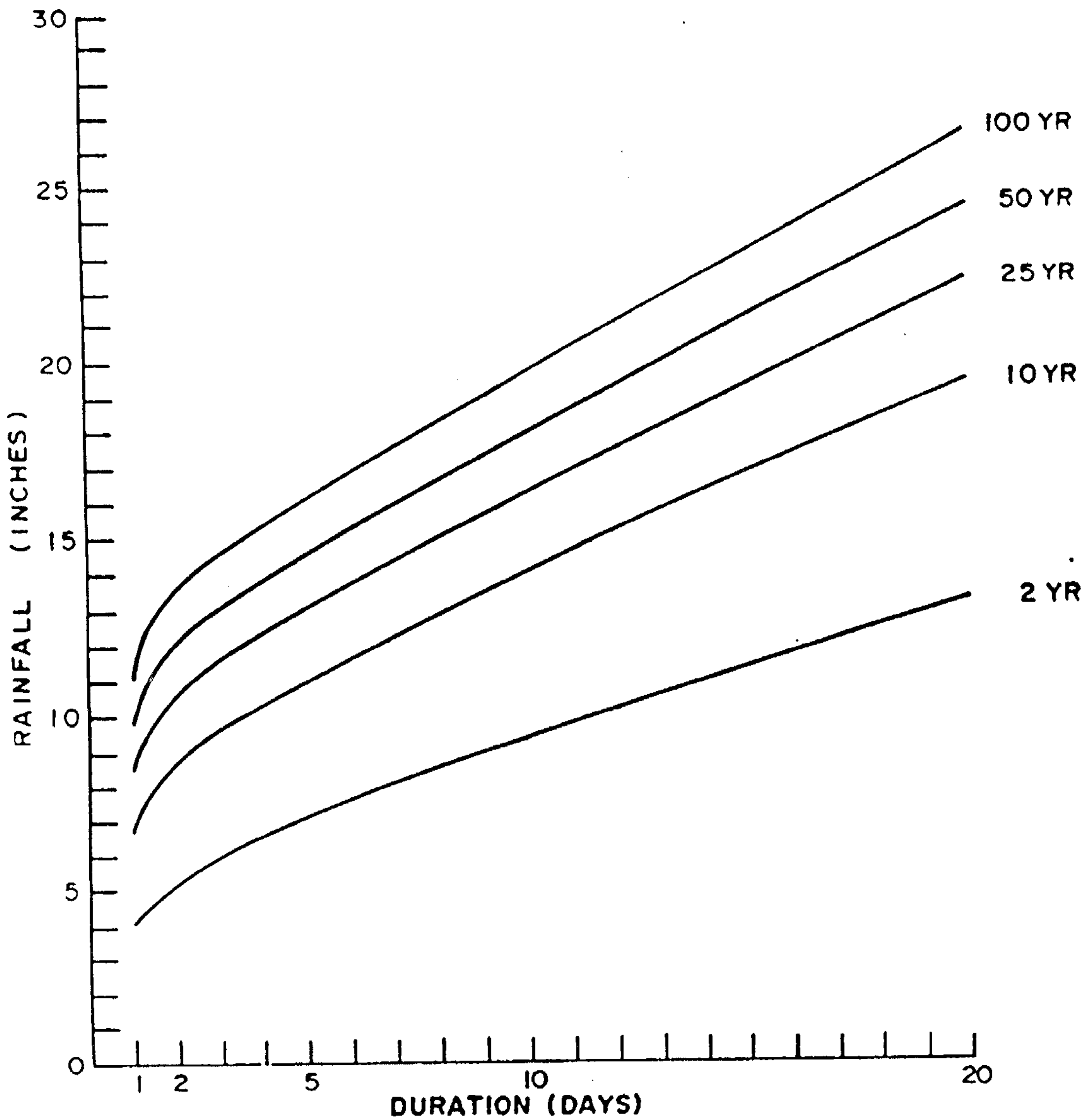
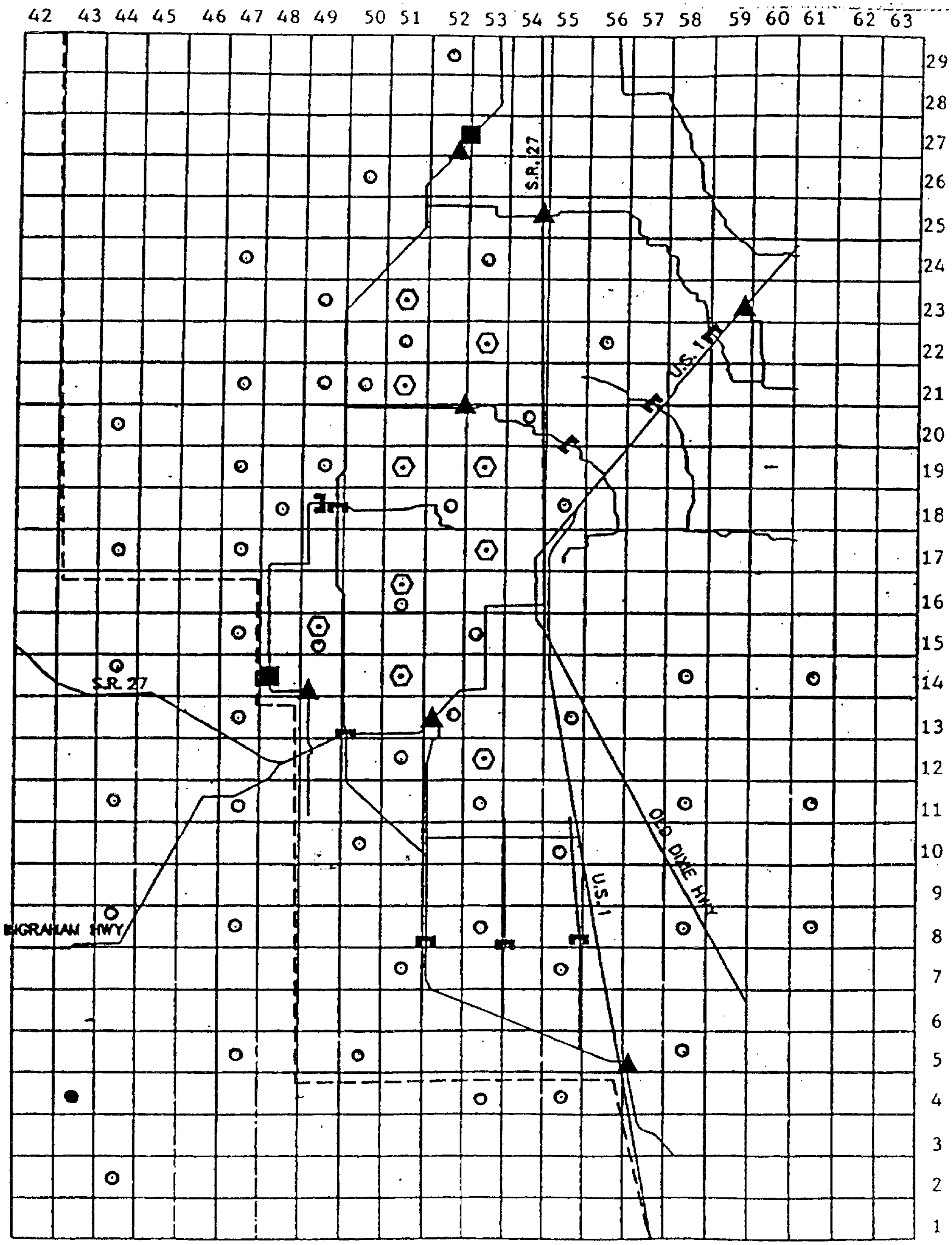
GENERAL REEVALUATION REPORT
Appendix A
Hydrology and Hydraulic Analysis

FIGURES



HOMESTEAD EXPERIMENT STATION
ANNUAL RAINFALL
(Expected Probability)

FIGURE A-1



ONE BY ONE GRID

Period of Record Cells o

Flood Stage Cells ⊙

FIGURE A-2

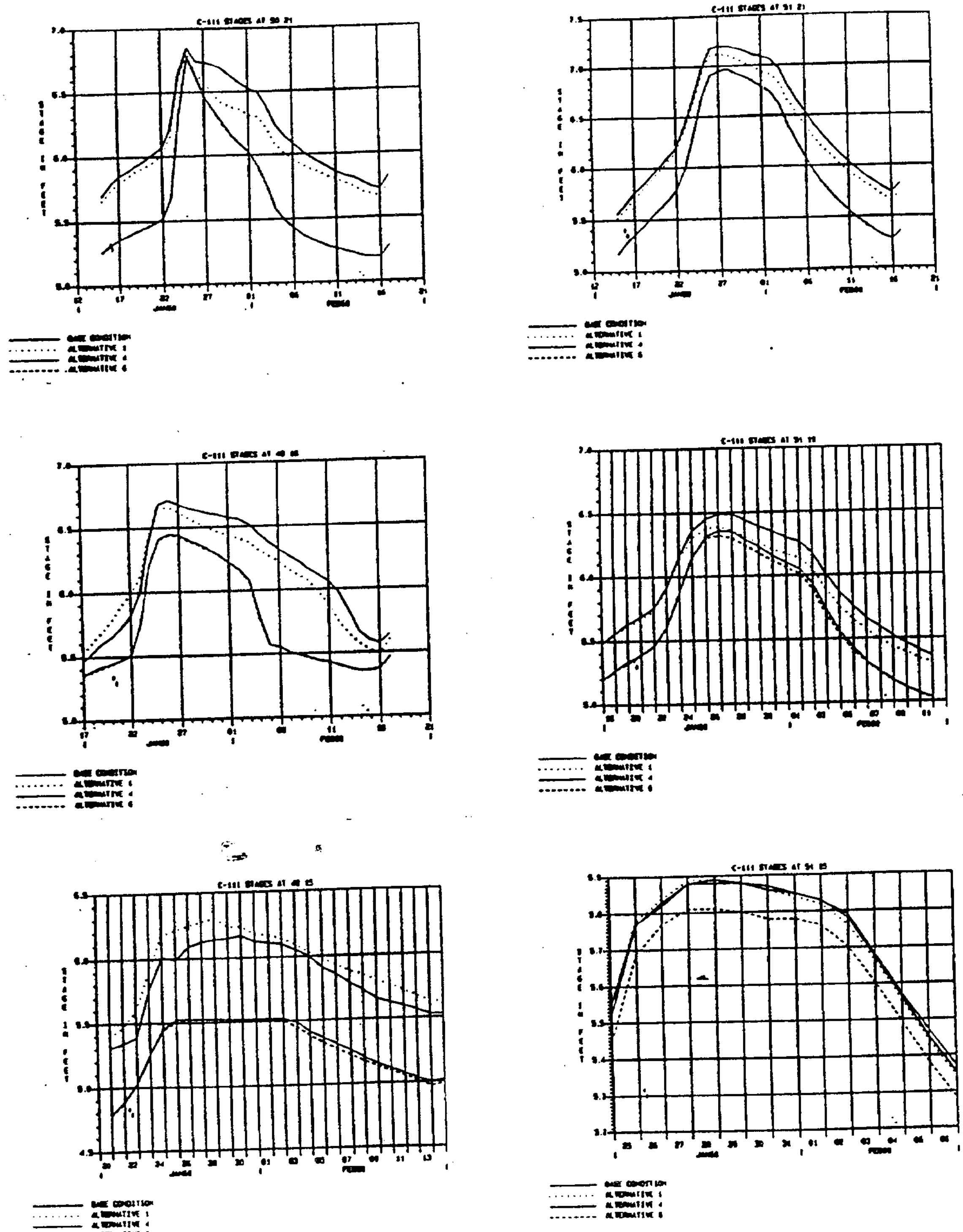


FIGURE A-3

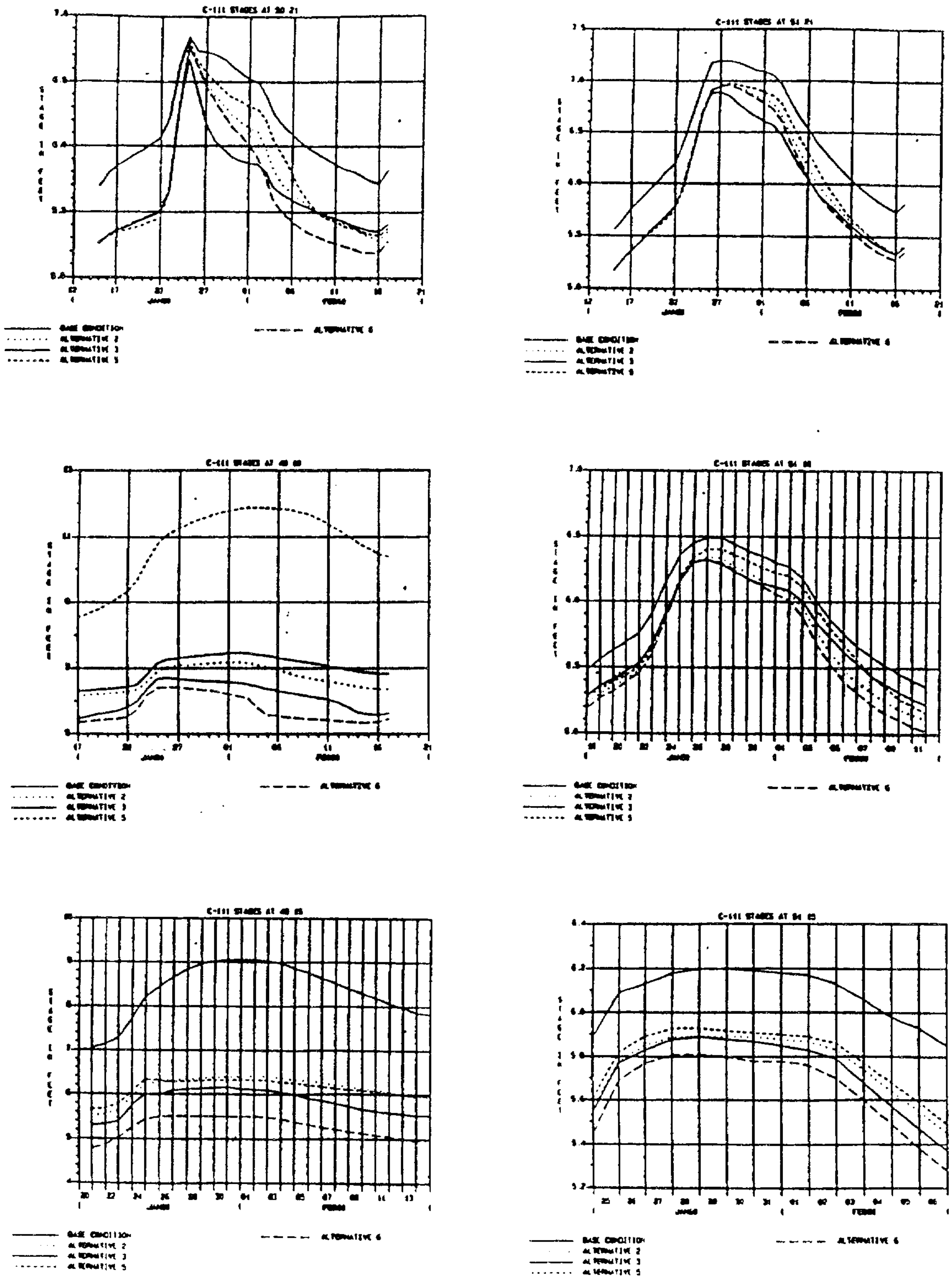
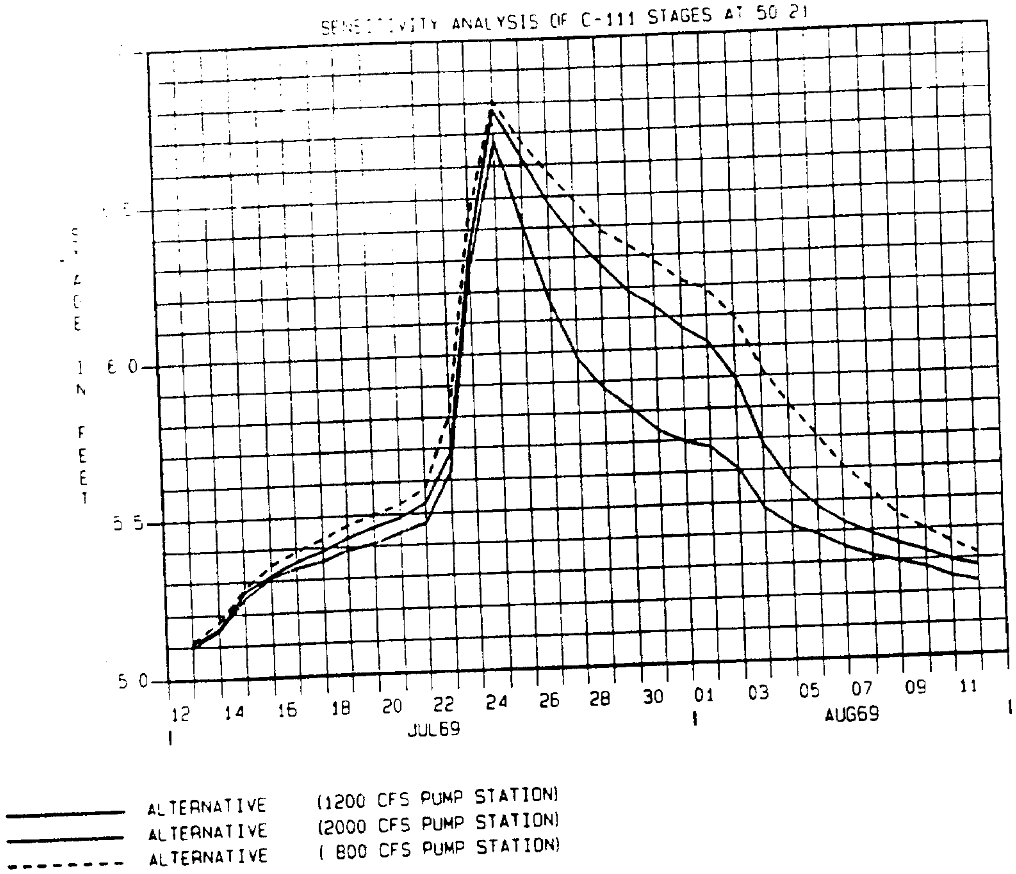


FIGURE A-3
(Continued)


SENSITIVITY ANALYSIS OF C-111 STAGES AT 50 21
STAGE IN FEET
6 0
5 5
5 0
12 14 16 18 20 22 24 26 28 30 01 03 05 07 09 11
JUL69
AUG69
ALTERNATIVE (1200 CFS PUMP STATION)
ALTERNATIVE (2000 CFS PUMP STATION)
ALTERNATIVE (800 CFS PUMP STATION)

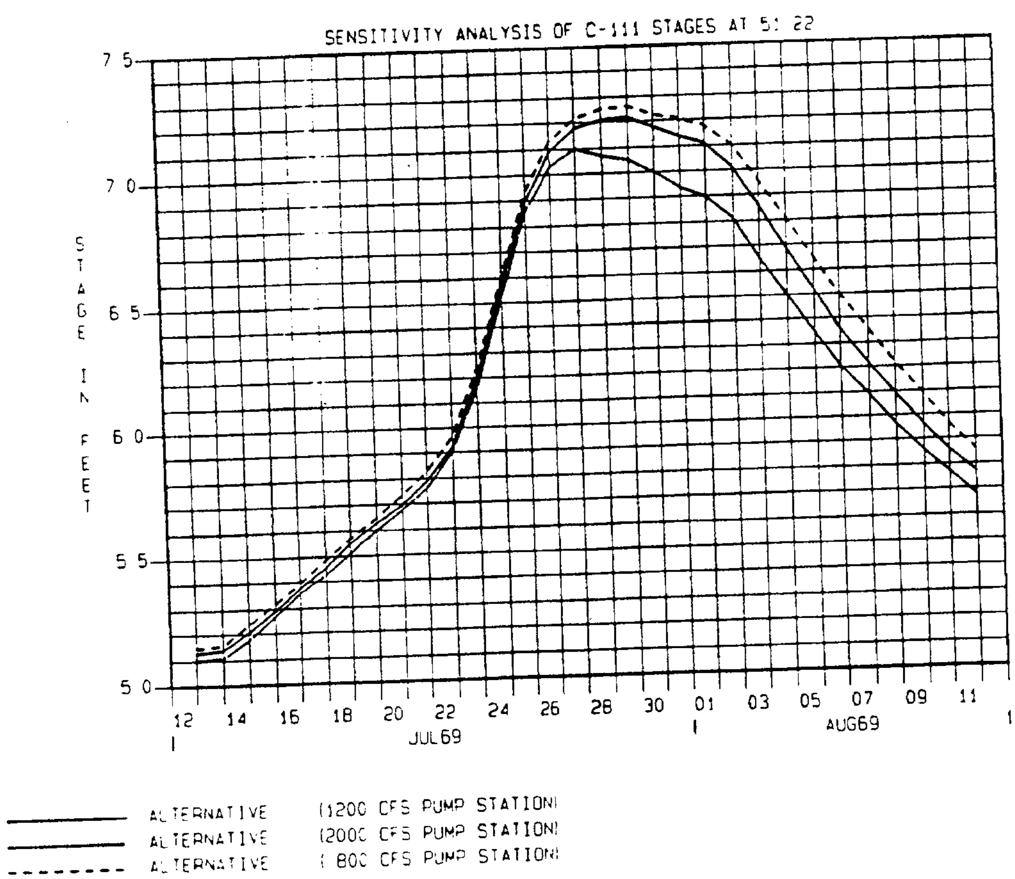

SENSITIVITY ANALYSIS OF C-111 STAGES AT 51 22
STAGE IN FEET
7 5
7 0
6 5
6 0
5 5
5 0
12 14 16 18 20 22 24 26 28 30 01 03 05 07 09 11
JUL69
AUG69
ALTERNATIVE (1200 CFS PUMP STATION)
ALTERNATIVE (2000 CFS PUMP STATION)
ALTERNATIVE (800 CFS PUMP STATION)

FIGURE A-4

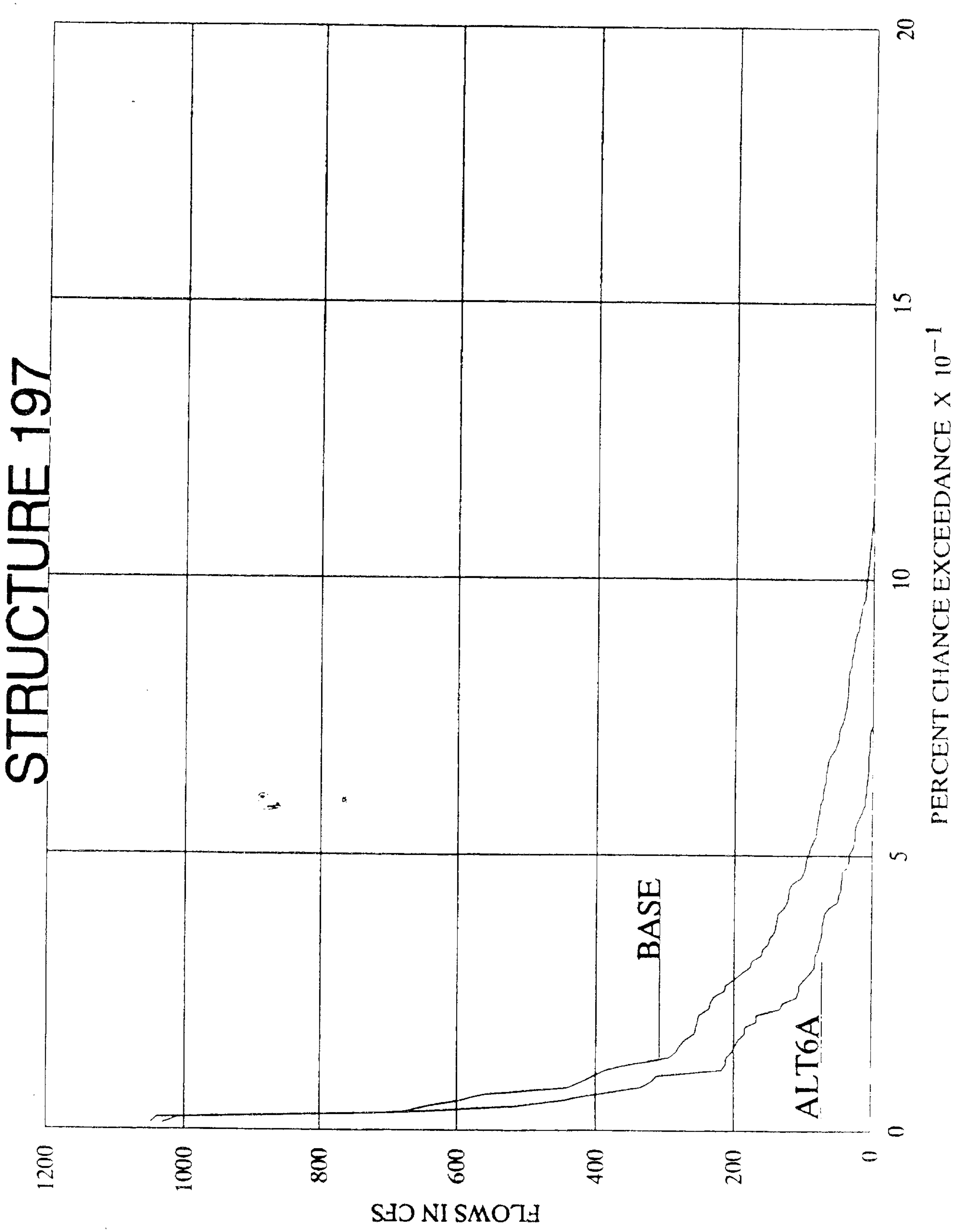
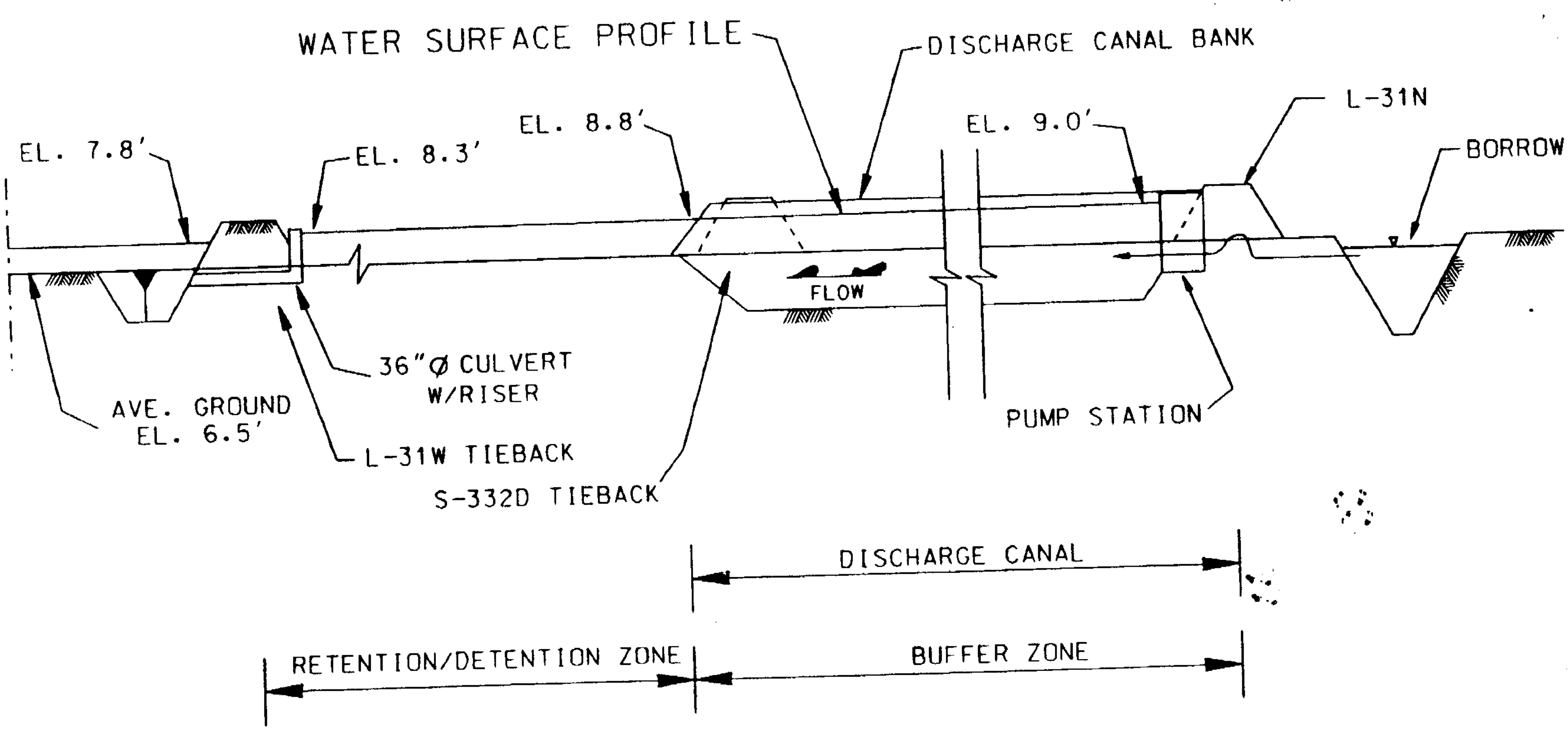

STRUCTURE 197
BASE
ALT6A
FLOWS IN CFS
PERCENT CHANCE EXCEEDANCE X 10^{-1}
0
200
400
600
800
1000
1200
0
5
10
15
20

FIGURE A-5

HYDRAULIC PROFILE

TYPICAL FROM PUMP STATION ACROSS RETENTION/DETENTION AREA THROUGH CULVERT/RISER

ALTERNATIVE 6A, RECOMMENDED PLAN



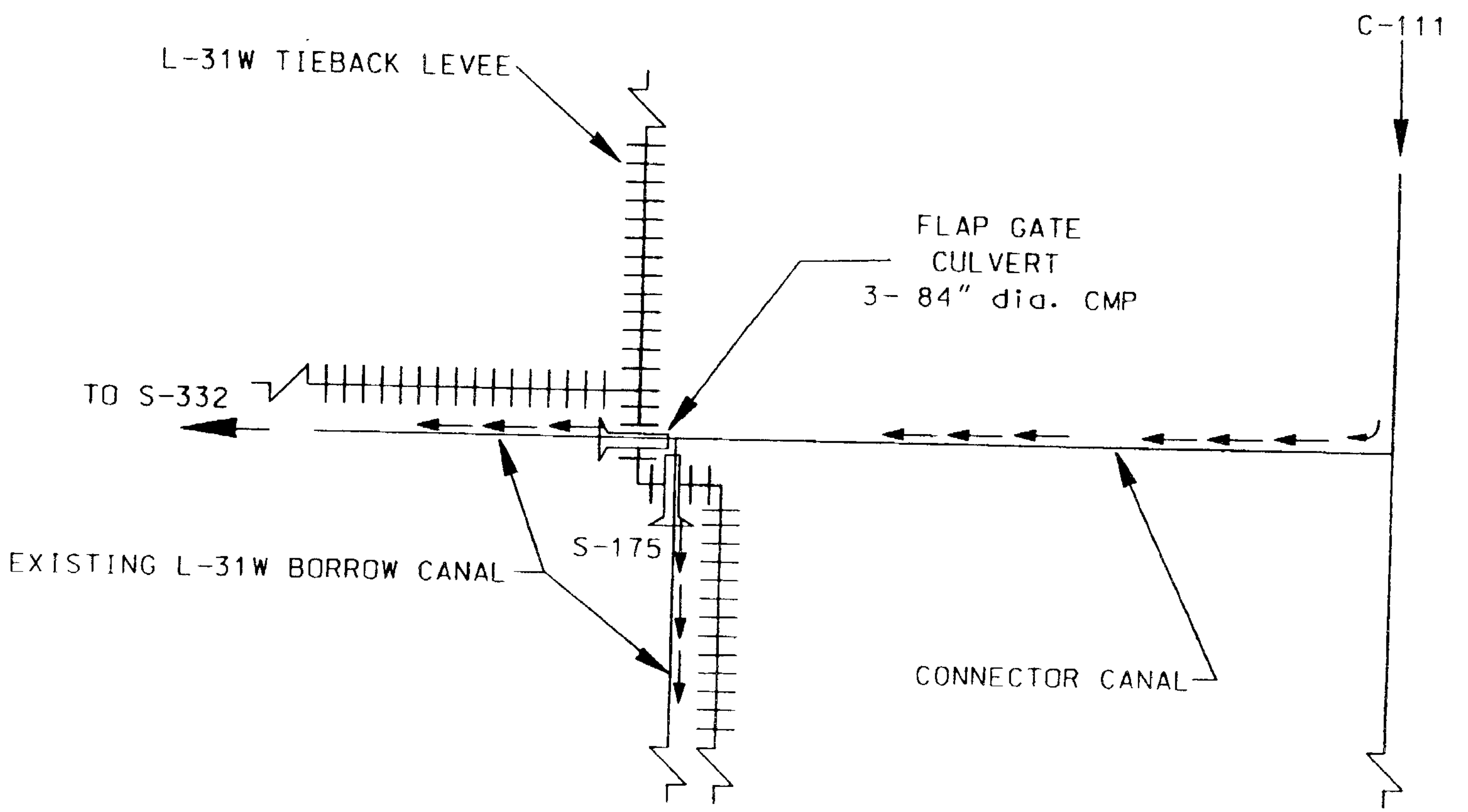
NOT TO SCALE

FIGURE A-6

SCHEMATIC PLAN LAYOUT

CONNECTOR CANAL, CONTROLLED CULVERTS, AND TEE-CONNECTION FOR S-332 & S-175

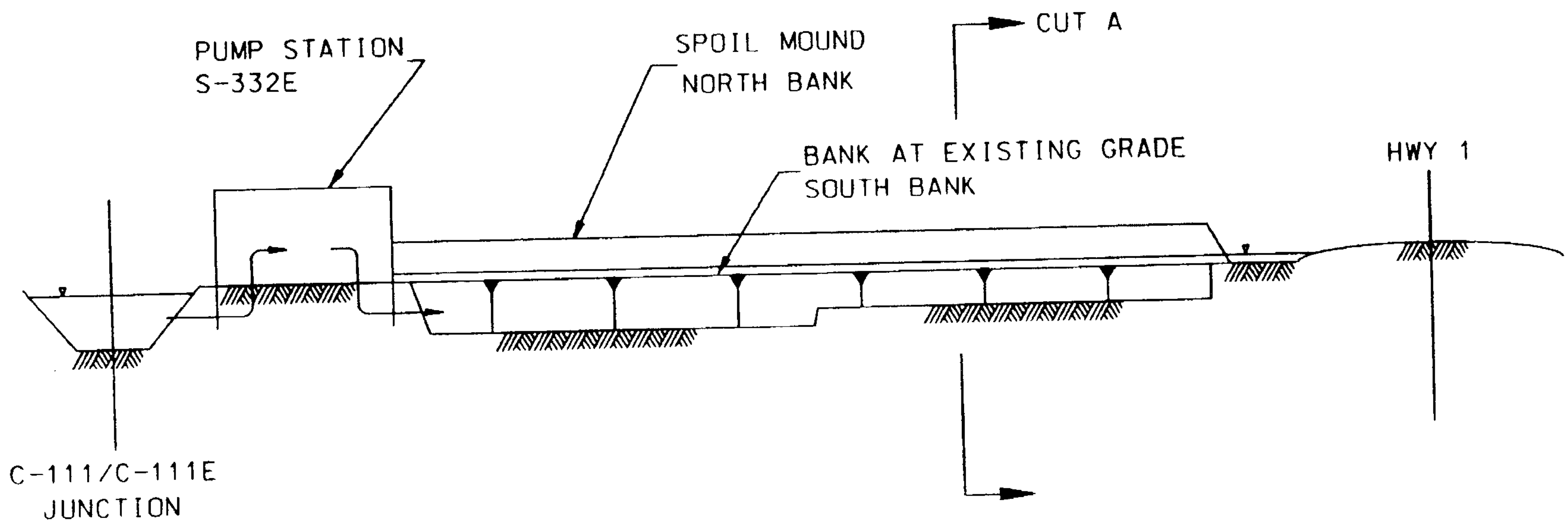
ALTERNATIVE 6A, RECOMMENDED PLAN



NOT TO SCALE

FIGURE A-7

SCHEMATIC PROFILE
CANAL 111 NORTH
ALTERNATIVE 6A. RECOMMENDED PLAN



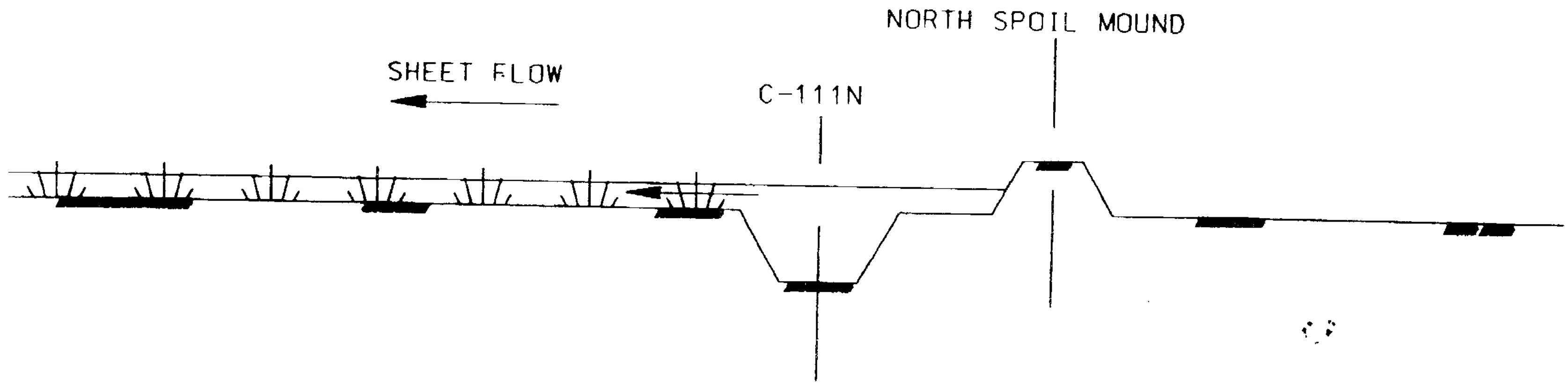
NOT TO SCALE

FIGURE A-8

CUT A

CANAL 111 NORTH

ALTERNATIVE 6A, RECOMMENDED PLAN



NOT TO SCALE

FIGURE A-9

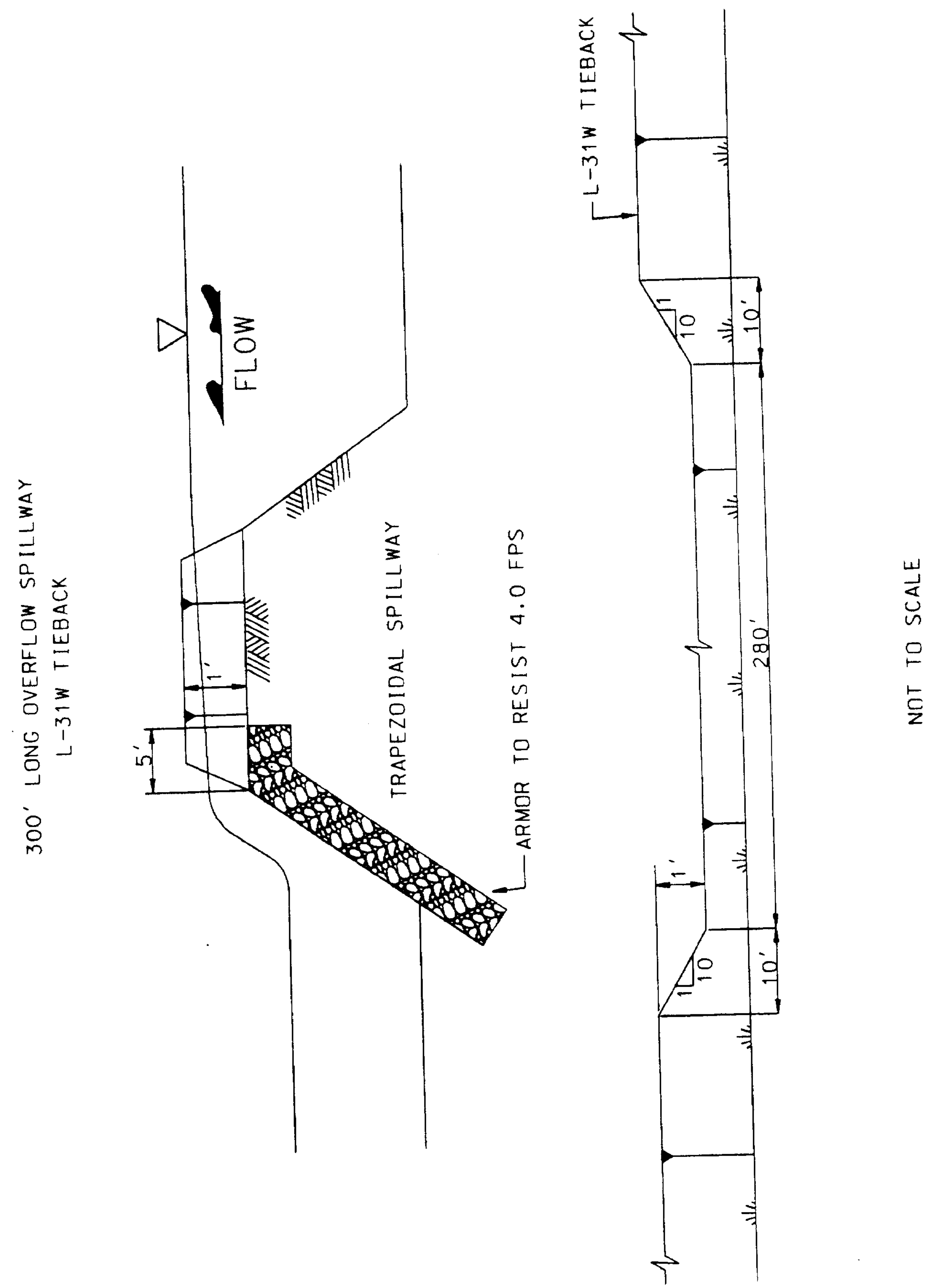

300' LONG OVERFLOW SPILLWAY
L-31W TIEBACK
TRAPEZOIDAL SPILLWAY
ARMOR TO RESIST 4.0 FPS
FLOW
5'
1'
L-31W TIEBACK
1
10
10'
280'
1'
NOT TO SCALE

FIGURE A-10

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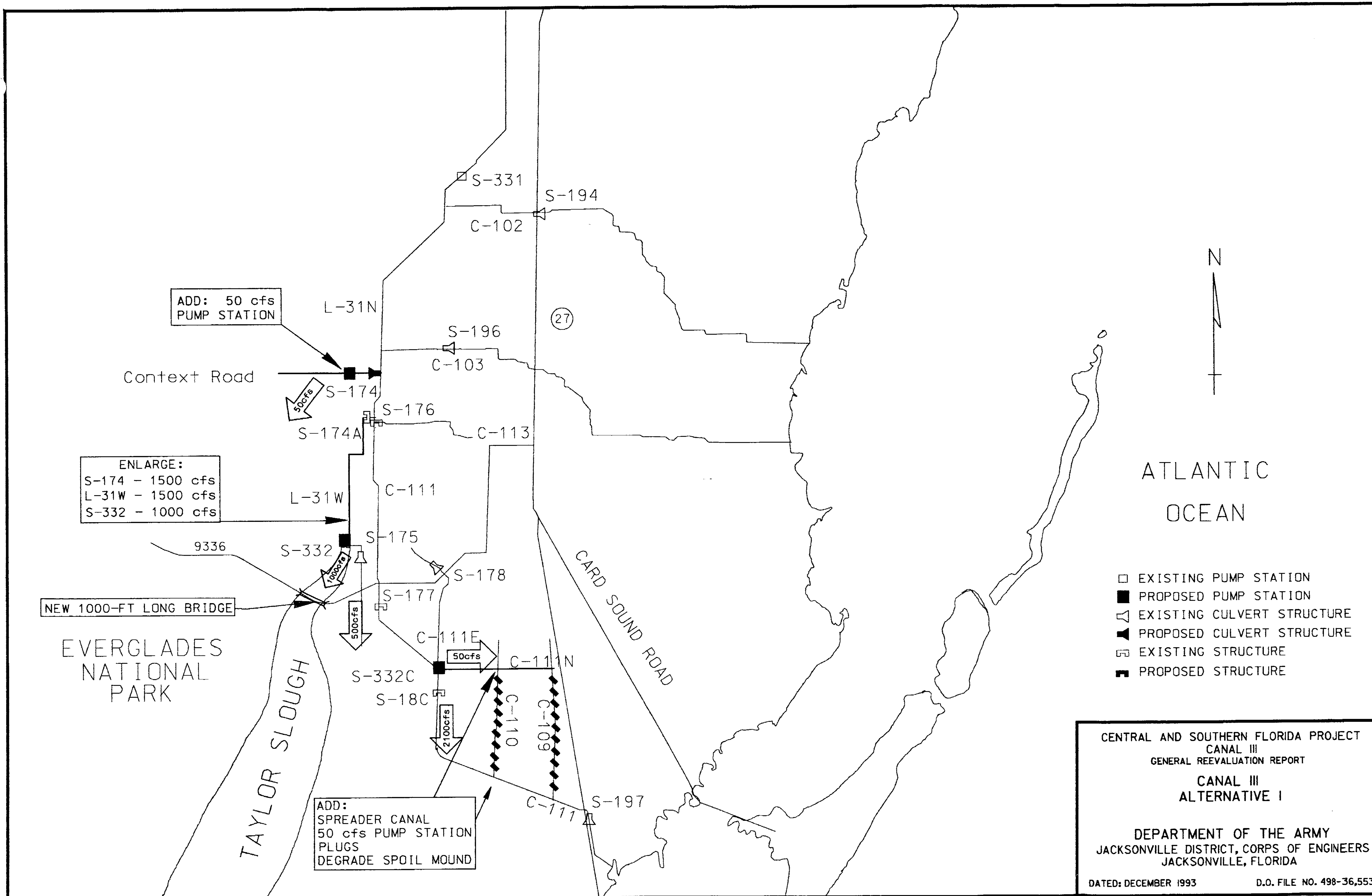
GENERAL REEVALUATION REPORT
Appendix A
Hydrology and Hydraulic Analysis

PLATES


S-331
S-194
C-102
N
27
ADD: 50 cfs
PUMP STATION
L-31N
S-196
C-103
Context Road
50cfs
S-174
S-176
S-174A
C-113
ENLARGE:
S-174 - 1500 cfs
L-31W - 1500 cfs
S-332 - 1000 cfs
L-31W
C-111
ATLANTIC
OCEAN
9336
S-332
1000cfs
S-175
S-178
CARD SOUND ROAD
NEW 1000-FT LONG BRIDGE
S-177
500cfs
EVERGLADES
NATIONAL
PARK
C-111E
50cfs
C-111N
S-332C
S-18C
C-110
C-109
2100cfs
TAYLOR SLOUGH
ADD:
SPREADER CANAL
50 cfs PUMP STATION
PLUGS
DEGRADE SPOIL MOUND
C-111
S-197
EXISTING PUMP STATION
PROPOSED PUMP STATION
EXISTING CULVERT STRUCTURE
PROPOSED CULVERT STRUCTURE
EXISTING STRUCTURE
PROPOSED STRUCTURE
CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL III
GENERAL REEVALUATION REPORT
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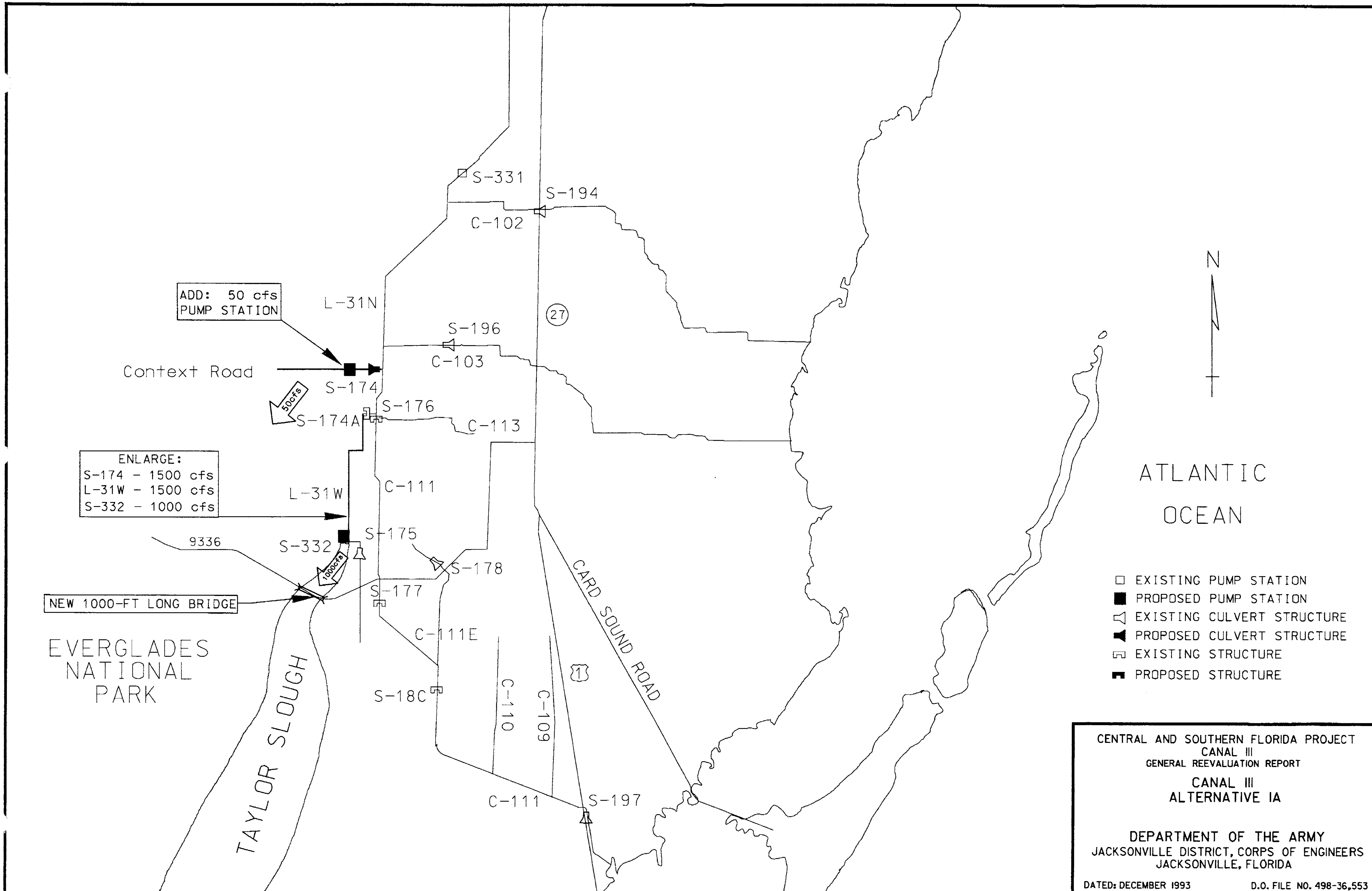
ALTERNATIVE I
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
DATED: DECEMBER 1993
D.O. FILE NO. 498-36,553

PLATE A-I



S-331
S-194
C-102
ADD: 50 cfs
PUMP STATION
L-31N
27
S-196
C-103
Context Road
S-174
50cfs
S-174A
S-176
C-113
ENLARGE:
S-174 - 1500 cfs
L-31W - 1500 cfs
S-332 - 1000 cfs
L-31W
C-111
9336
S-332
S-175
1000cfs
S-178
S-177
NEW 1000-FT LONG BRIDGE
C-111E
EVERGLADES
NATIONAL
PARK
TAYLOR SLOUGH
S-18C
C-110
C-109
1
CARD SOUND ROAD
C-111
S-197
N
ATLANTIC
OCEAN
EXISTING PUMP STATION
PROPOSED PUMP STATION
EXISTING CULVERT STRUCTURE
PROPOSED CULVERT STRUCTURE
EXISTING STRUCTURE
PROPOSED STRUCTURE
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PLATE A-2

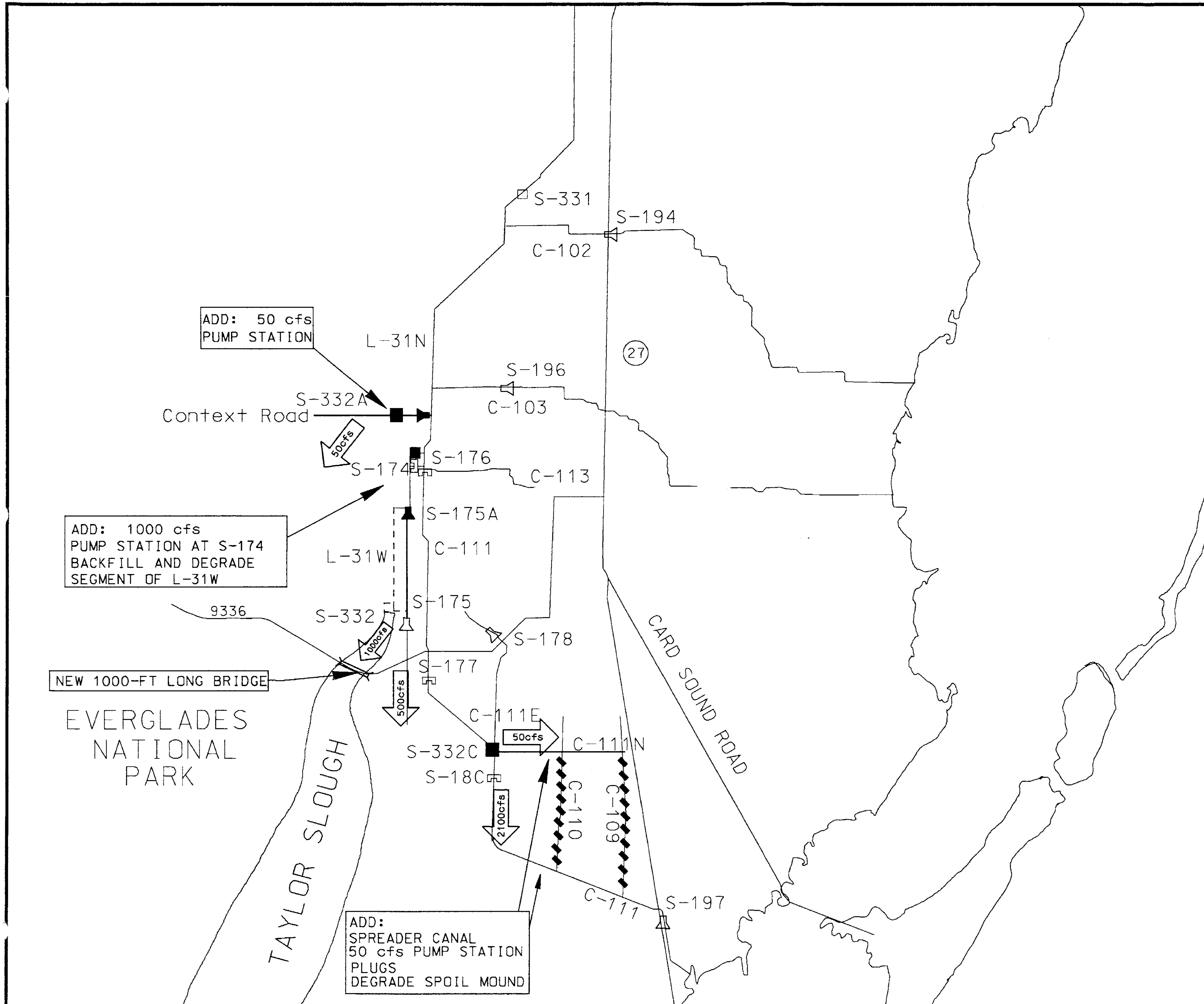

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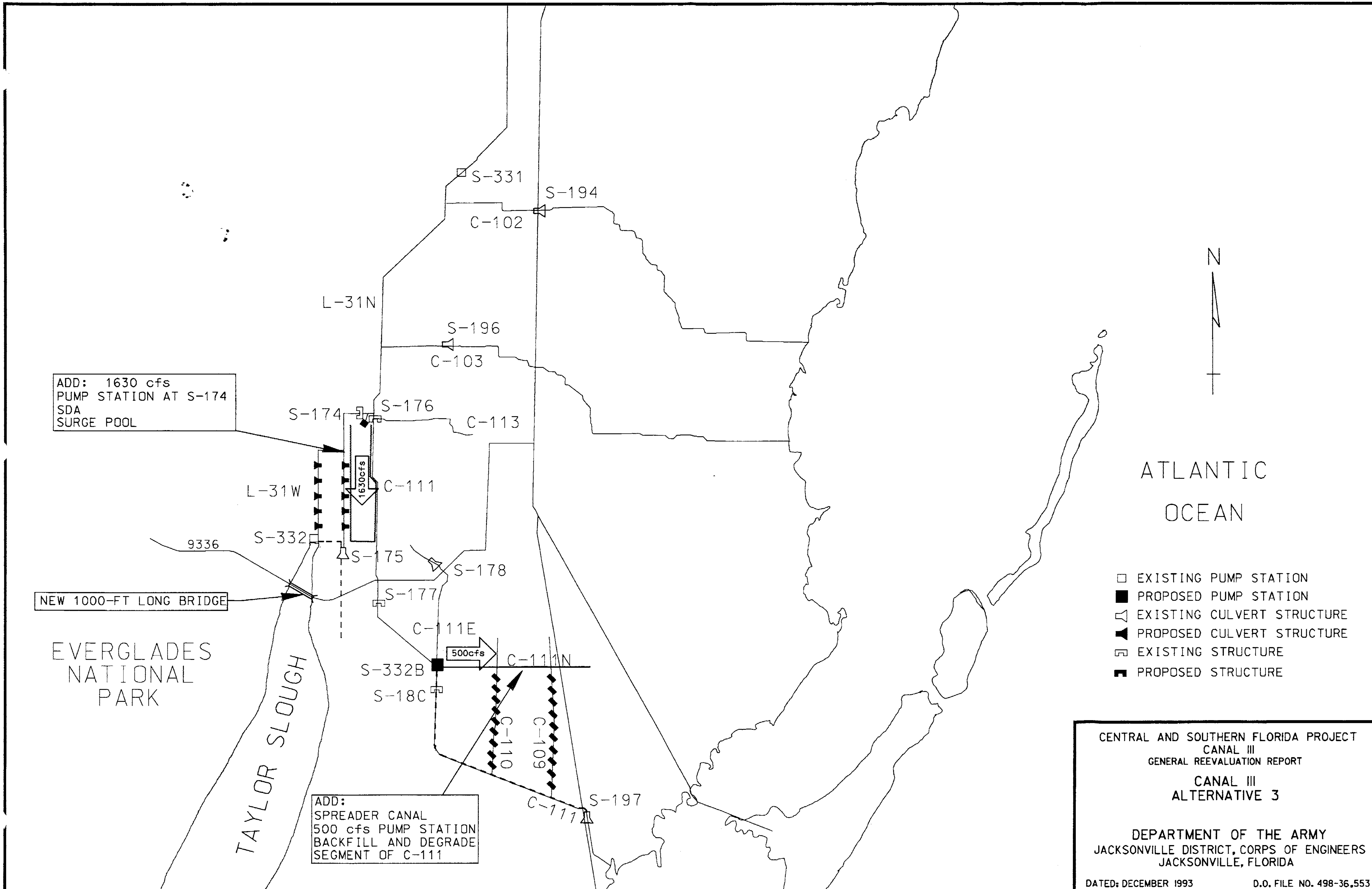
PLATE A-3



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CANAL III
ALTERNATIVE 3

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JACKSONVILLE, FLORIDA

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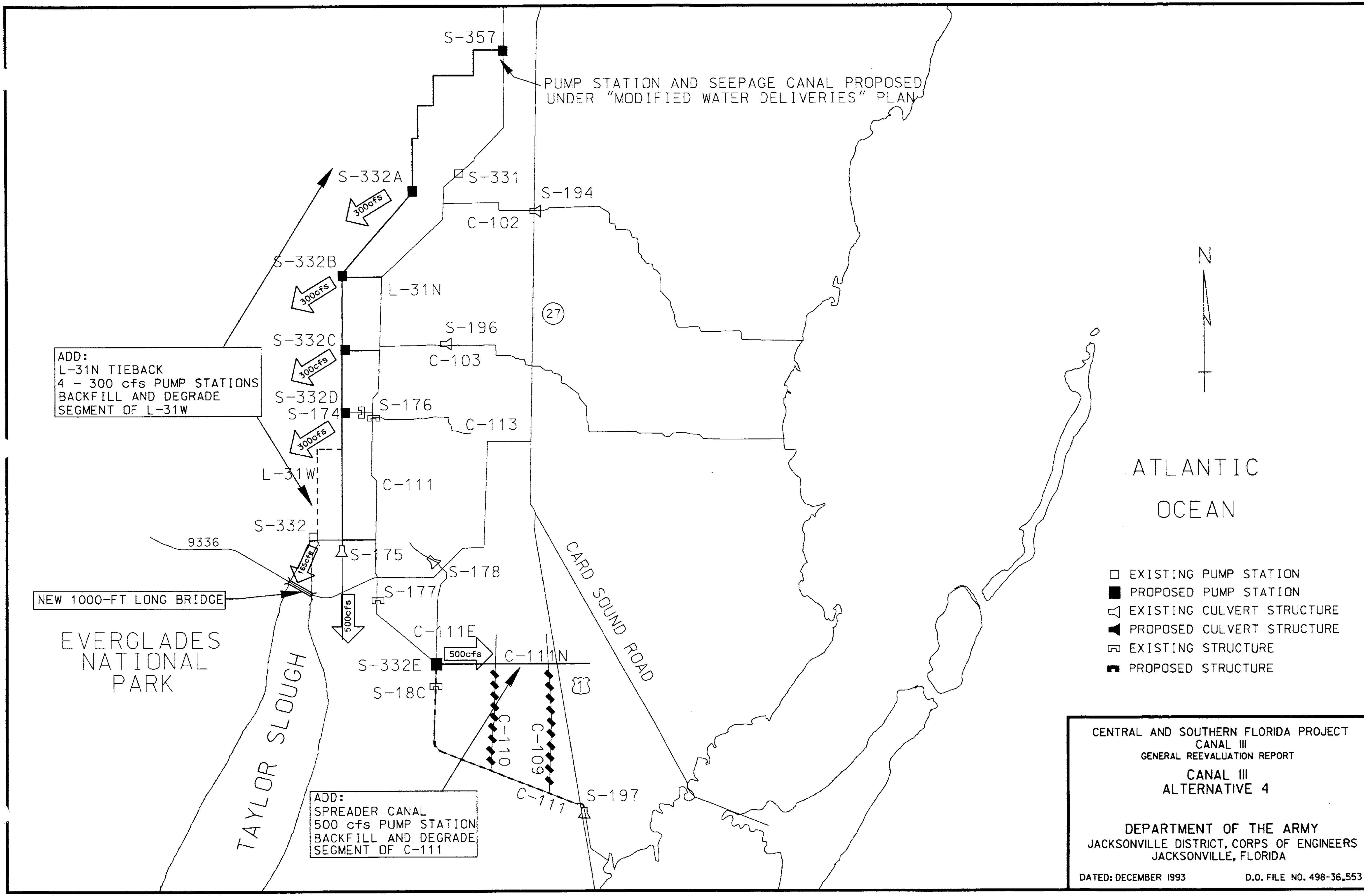
PLATE A-4



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CANAL III
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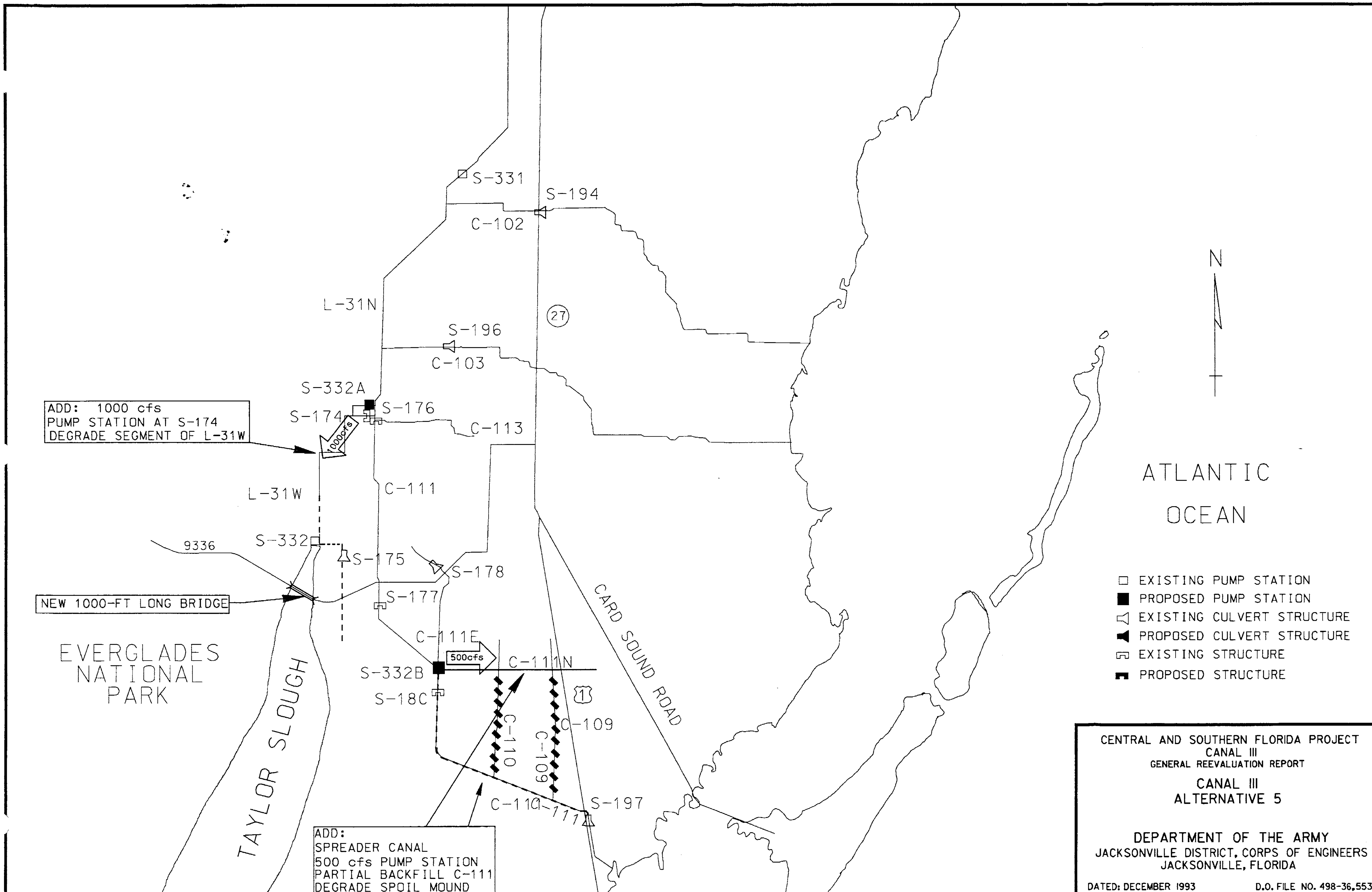
JACKSONVILLE, FLORIDA

DATED: DECEMBER 1993 D.O. FILE NO. 498-36.553

PLATE A-5



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CANAL III
ALTERNATIVE 5

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JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

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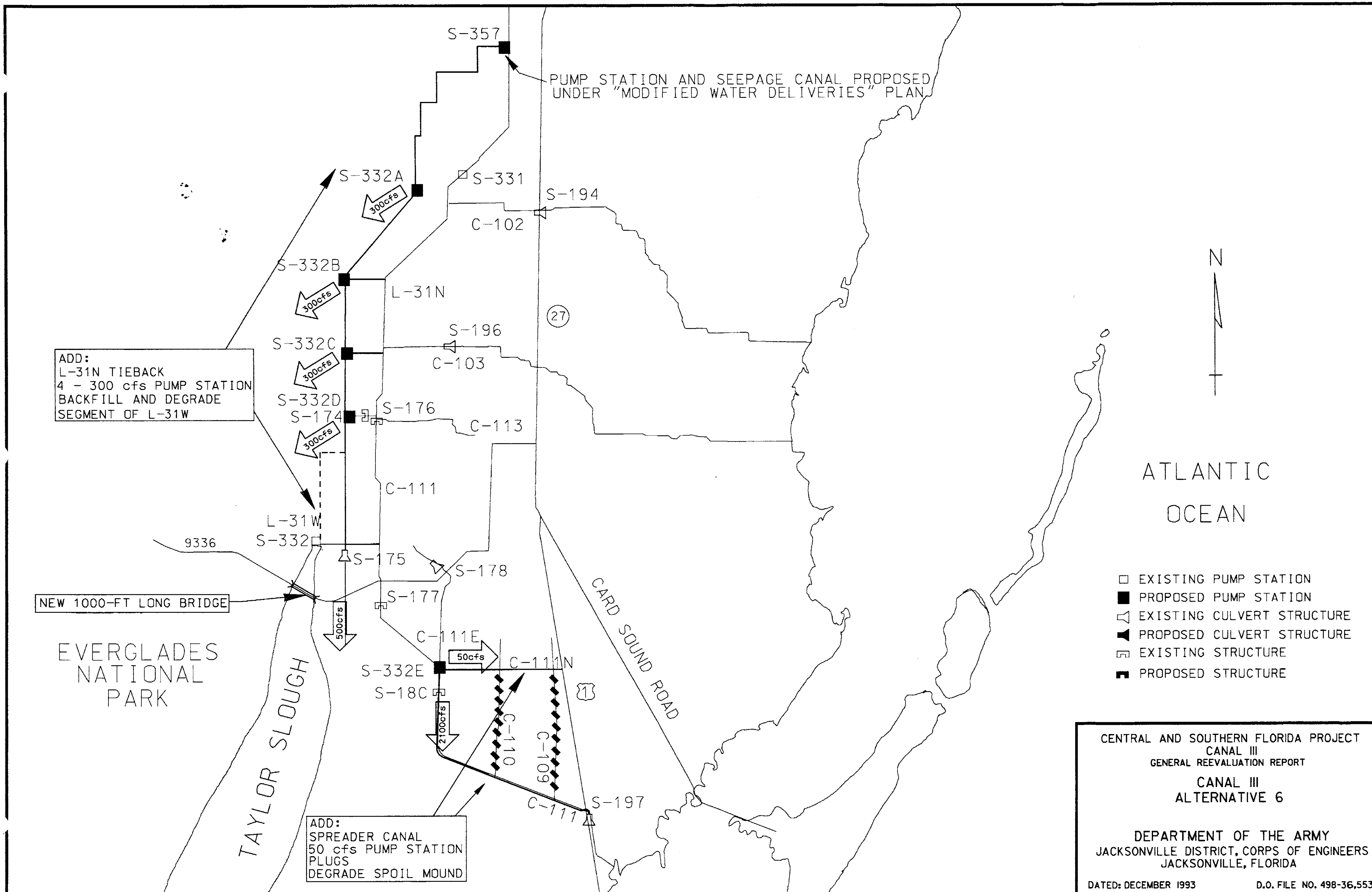
PLATE A-6



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CANAL III
ALTERNATIVE 6

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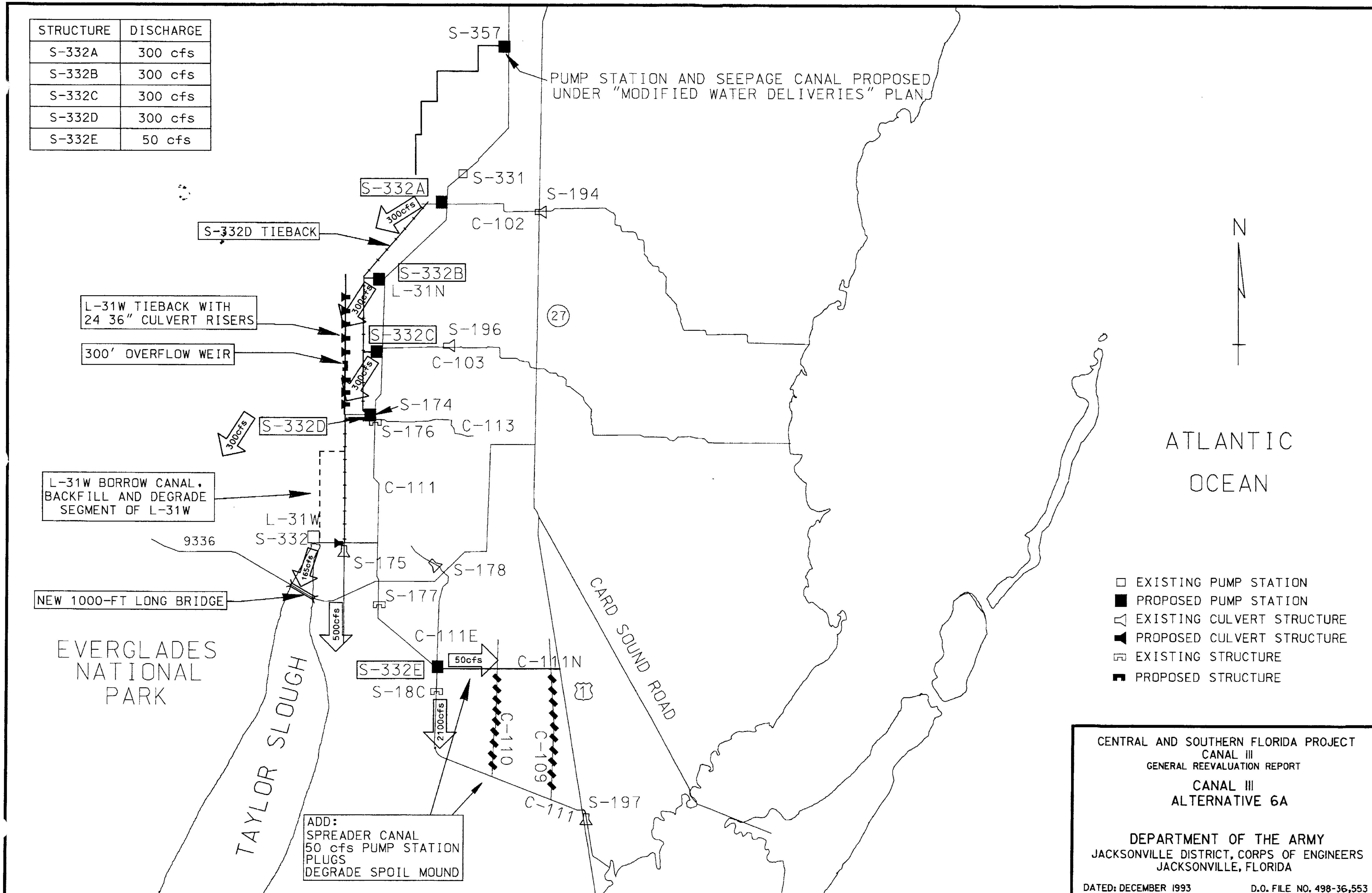
PLATE A-7



STRUCTURE	DISCHARGE
S-332A	300 cfs
S-332B	300 cfs
S-332C	300 cfs
S-332D	300 cfs
S-332E	50 cfs

CENTRAL AND SOUTHERN FLORIDA PROJECT
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DEPARTMENT OF THE ARMY
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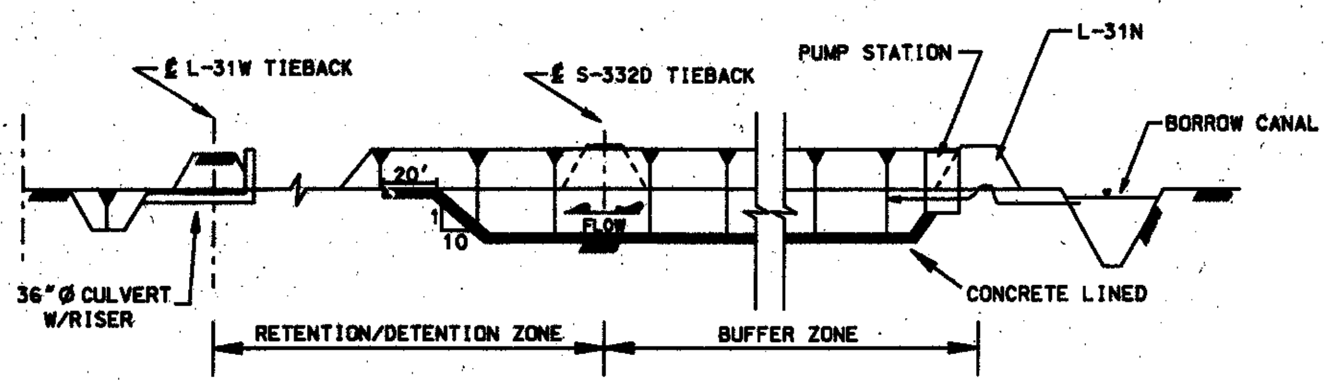
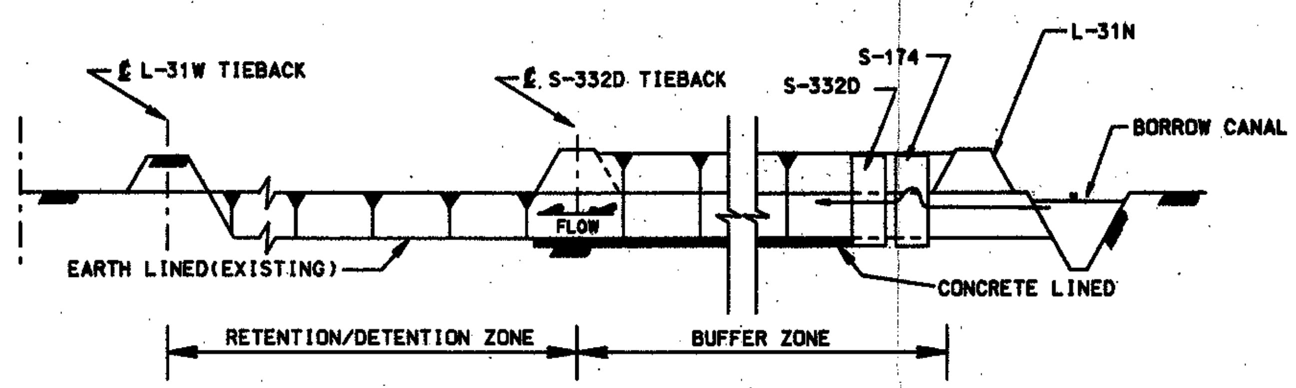
PLATE A-8

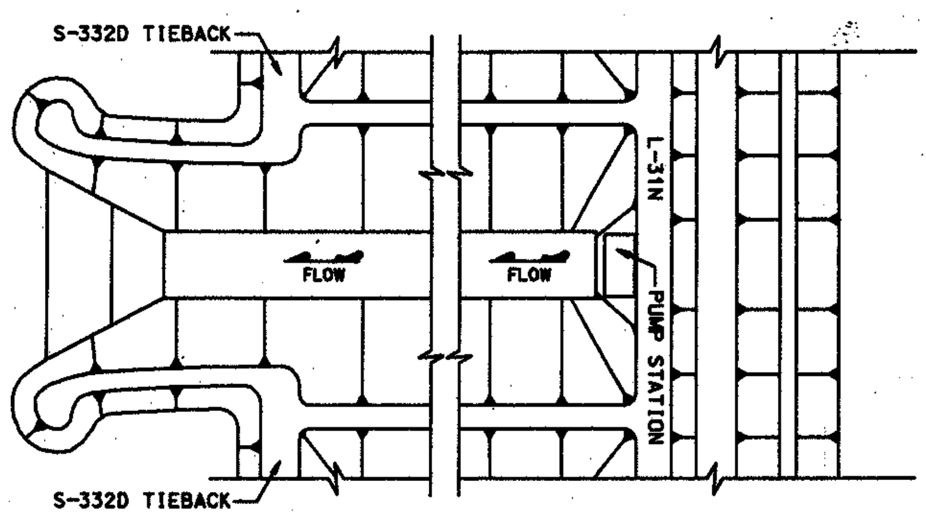
SCHEMATIC PROFILE
TYPICAL FOR DISCHARGE CANAL FROM S-332A, S-332B, & S-332C
ALTERNATIVE 6A



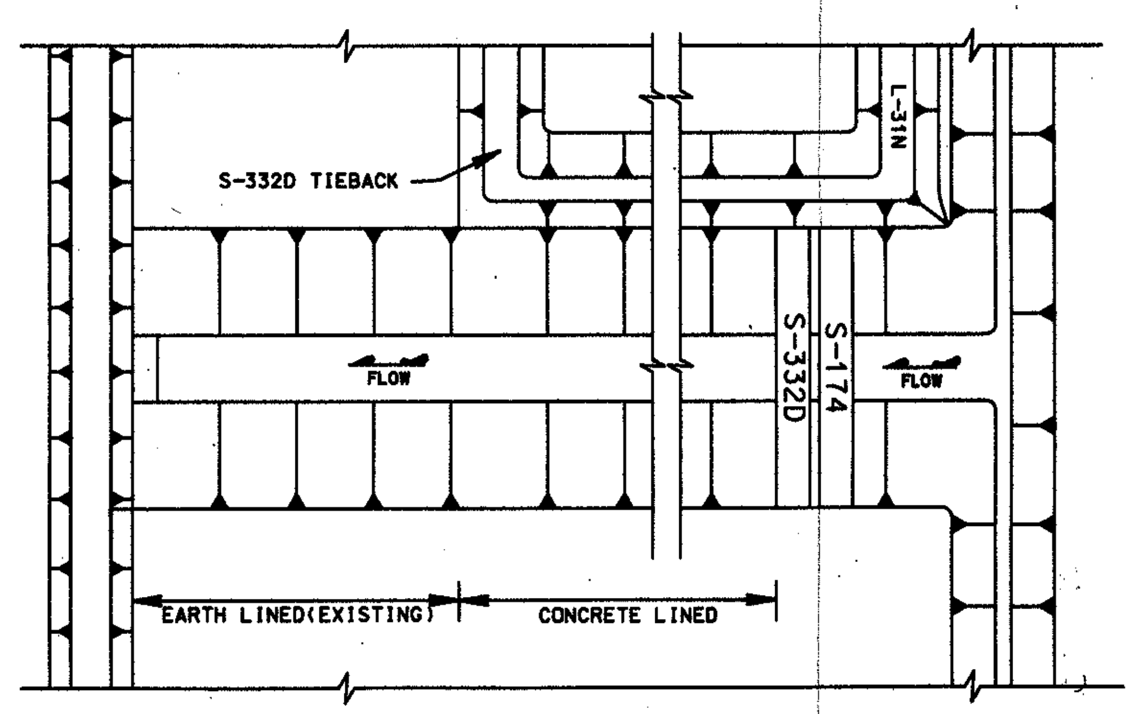
SCHEMATIC PROFILE
DISCHARGE CANAL FROM S-332D
ALTERNATIVE 6A



SCHEMATIC PLAN
TYPICAL FOR DISCHARGE CANAL FROM S-332A, S-332B, & S-332C
ALTERNATIVE 6A



SCHEMATIC PLAN
DISCHARGE CANAL FROM S-332D
ALTERNATIVE 6A



NOT TO SCALE

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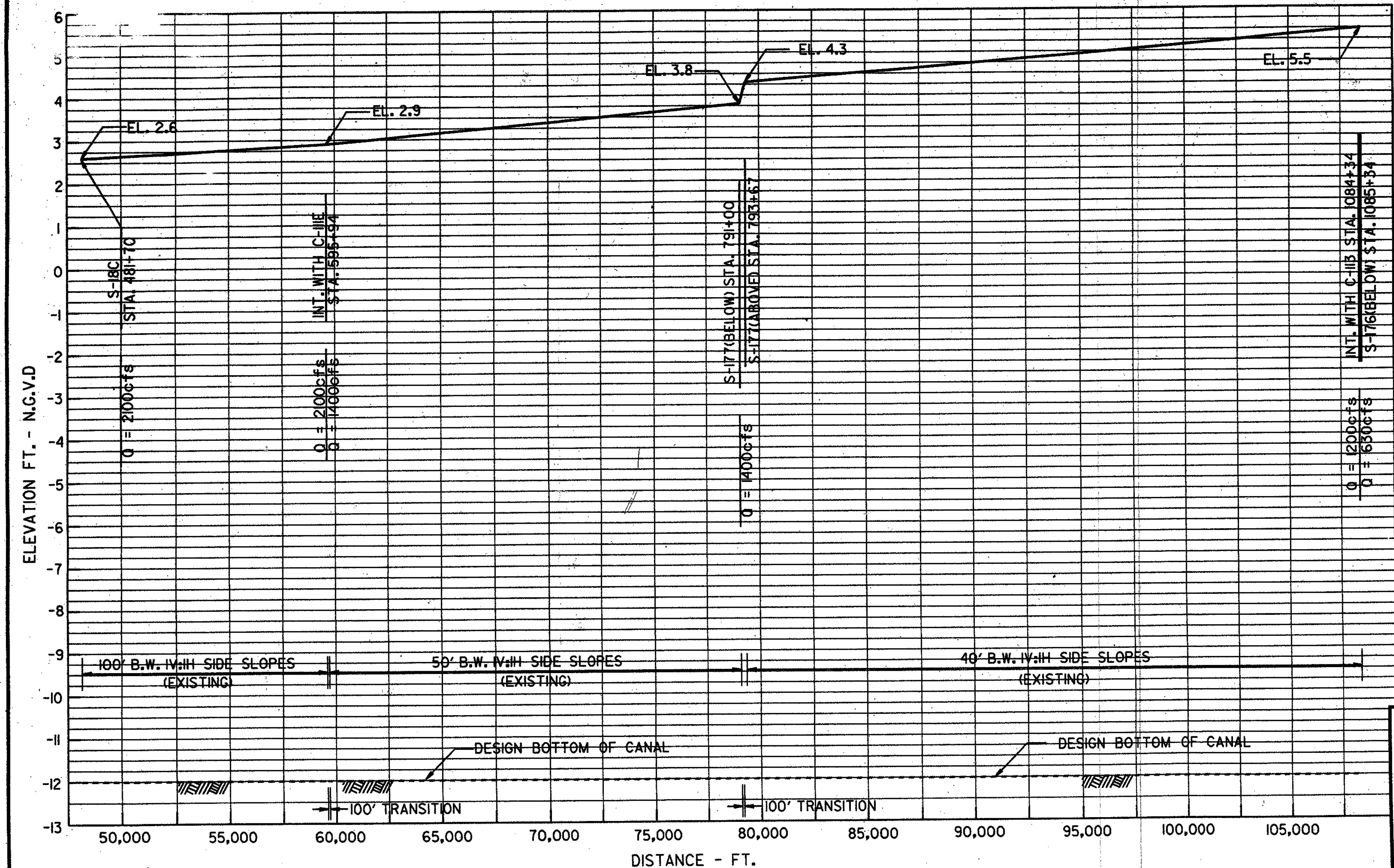
SCHEMATIC PLAN AND PROFILE
PUMP STATION DISCHARGE CANAL AND CULVERT/RISERS

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: MARCH 1994 D.O. FILE NO. 498-36,553



CENTRAL AND SOUTHERN FLORIDA PROJECT
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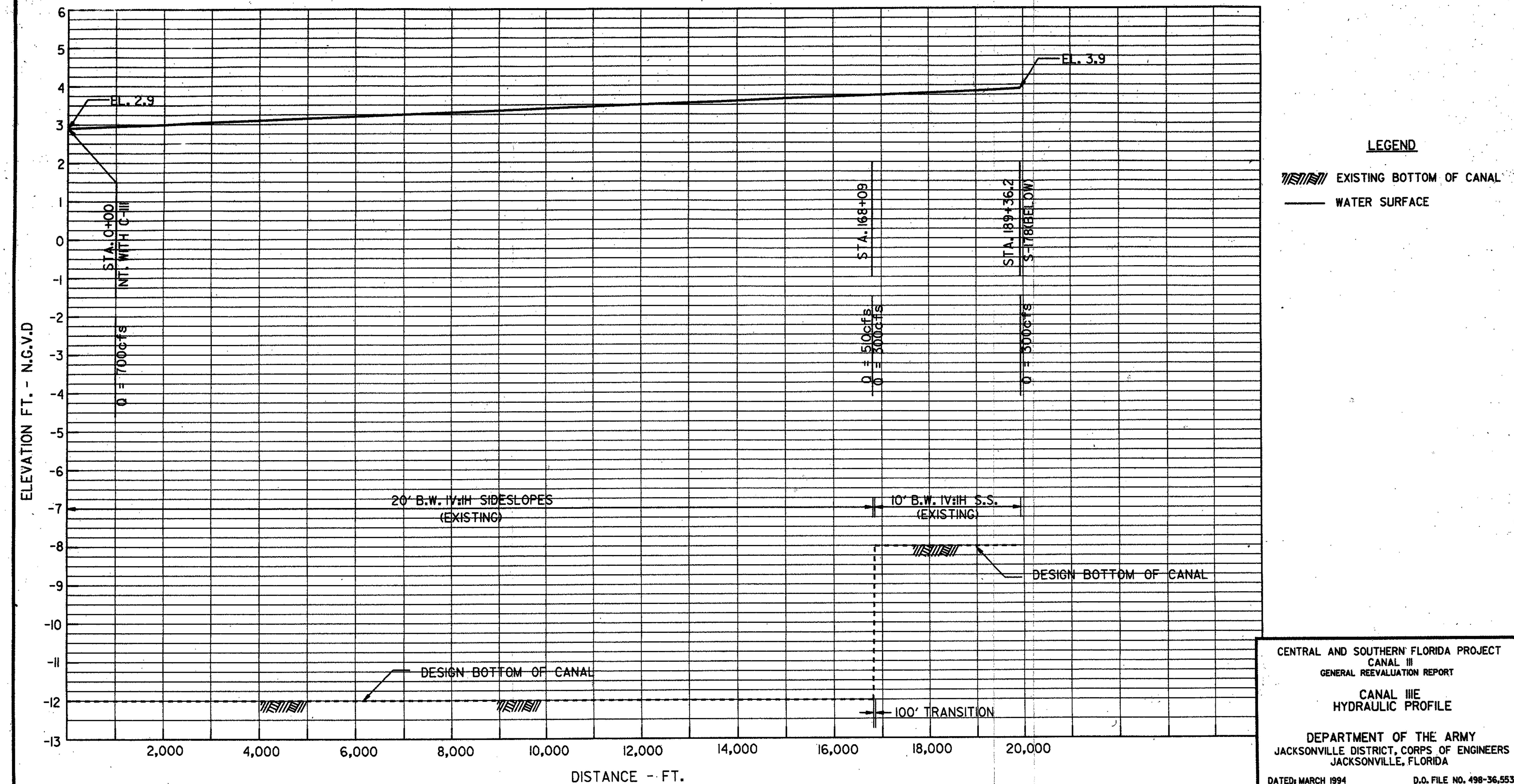
CANAL 111
FROM S-18C TO S-176
HYDRAULIC PROFILE

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: MARCH 1994 | D.O. FILE NO. 498-36,553

PLATE A-10



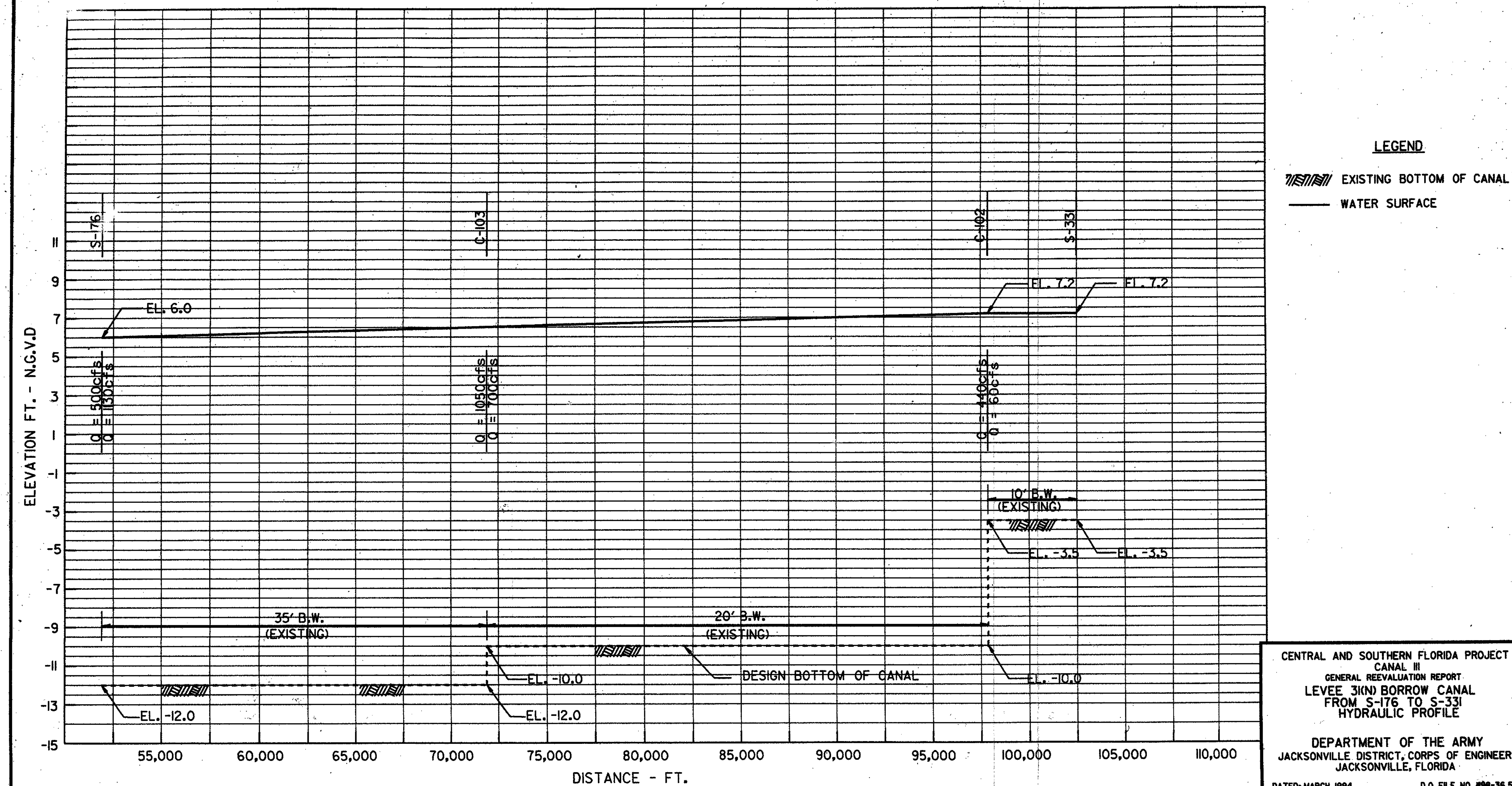
CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL 111
GENERAL REEVALUATION REPORT

CANAL 111E
HYDRAULIC PROFILE

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: MARCH 1994 D.O. FILE NO. 498-36,553

PLATE A-11



CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL 111
GENERAL REEVALUATION REPORT
LEVEE 31(N) BORROW CANAL
FROM S-176 TO S-331
HYDRAULIC PROFILE

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: MARCH 1994 D.O. FILE NO. 198-36,553

PLATE A-12

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Appendix B
Geotechnical Investigations

1. Investigations Performed. No new subsurface investigations were performed for this report. However, during the 1960's and 1970's, numerous core borings were obtained along the alignments of L-31W, C-111, C-111E, C-109, and C-110. Refer to Plates B-1 through B-6 for the geologic sections. Also during the 1960's and 1970's, core borings were obtained for the C-111 basin structures. The core boring logs for S-332, S-174, S-175, and S-18C are included in this section. Core borings and laboratory tests will be conducted for the detailed design phase.

2. Materials Encountered. The materials in the vicinity of the proposed features are anticipated to be characteristic of the general geology of the area. A layer of soft, unconsolidated material is underlain by medium-hard limestone. The overburden material varies in thickness and composition. The material is silty in some areas and highly organic along other reaches. The medium-hard limestone overlies a hard, sometimes cavernous, limestone formation. Penetration of the rock during drilling occasionally resulted in a highly fractured sample with poor recovery.

3. Excavation. The surficial materials can be removed using conventional methods. Excavation of the underlying rock will require blasting. Presplit blasting will be required for rock excavation adjacent to existing structures. Production blasting will be allowed for all other excavation.

4. Fill Material. The fill materials to be used for canal backfilling and levee construction will be limestone obtained from excavation operations and existing spoil mounds. Test pits will be used to determine the range of particle sizes in the existing spoil. It is anticipated that 70 percent of the blast material will be less than three inches in diameter; however, during blasting operations, occasionally dense slabs of limestone are encountered which will produce boulders three feet or greater in size. The boulders will be segregated from the suitable fill material.

5. Foundation Conditions and Settlement. The elevations for the structure foundations will be determined during the detail design phase. The structures will be founded on medium-hard to hard limestone which will provide adequate support. For the proposed levees, some settlement is expected where the levees are founded on the unconsolidated overburden. Settlement calculations will be performed in the detailed design phase to determine if overbuild is required.

6. Structure Dewatering. Dewatering for the five pump stations will be accomplished using a sheetpile cofferdam, a tremie concrete seal, and sump pumps. Due to the hardness of the rock, driving sheetpile will not be possible. Therefore, presplit blasting will be required along the sheetpile wall alignment. Based on past experience in the area, predrilling will be necessary for every third sheetpile location to facilitate installation. The culvert structures

will be constructed in the wet.

7. Stability Analysis. Based on existing canals in the C-111 basin, the canal side slopes (in rock) will be 1V:1H. The side slopes for the proposed levees will be 1V:3H. A detailed slope stability analysis will be conducted in the detailed design phase to determine if steeper embankment slopes will be stable. The critical factor will be the thickness of the unconsolidated overburden material.

8. Stone Protection. Based on the low exit velocities for all of the proposed culverts, riprap will not be required.

9. Proposed Cutoff Wall. Alternative 9 consists of an impermeable cutoff west of the agricultural areas. To evaluate the curtain wall alternative, an impervious barrier was modeled using the 2-dimensional finite element program ***FASTSEEP***. This program was used to calculate the quantity of seepage beneath a fully and partially penetrating cutoff barrier. The following assumptions were used in the analysis:

a) The geology of the area was assumed to consist of 45 feet of highly pervious limestone underlain by the much less permeable Tamiami Formation. This cross-section was assumed to be representative of the entire 16 mile length of wall.

b) The water level in ENP was assumed to be at ground level and the water level in the agricultural areas was assumed to be three feet below ground. This would be fairly representative of average daily conditions if this alternative were used.

c) The flow was assumed to be steady-state. Since average daily conditions were evaluated, this assumption would be accurate.

d) The horizontal permeability of the limestone aquifer was assumed to be 0.15 fps, which is 50% of the observed permeabilities in the C-111 area. The vertical permeability was assumed to be 0.015 fps which is 10% of the horizontal permeability. Both of these permeabilities are very low compared to the permeabilities observed in the field.

e) The wall was assumed to be imbedded 10 feet into the less permeable formation underlying the aquifer.

The seepage quantities from the finite element model were computed for the entire 16 mile length of wall. The results of the analysis are shown below:

Depth of Cutoff Wall (feet)	***Flow (cfs)***
55	7
40	4,250
30	6,250

From this analysis, it is apparent that an impermeable cutoff must extend the full depth of the aquifer to be effective. If the cutoff partially penetrates the aquifer, additional pump stations would be required to handle the resulting backseepage. This additional cost would make a partially penetrating cutoff much more expensive than a fully penetrating one.

It is important to note that the purpose of this model study was ***only*** to determine the necessary depth of imbedment for the cutoff and not to determine actual seepage rates. The results of this analysis agree with similar analyses done by the South Florida Water Management District. A 3-Dimensional groundwater model of the C-111 area is currently being developed to fully evaluate the water level impacts of this alternative during the detailed design phase. From an engineering standpoint, this alternative is very feasible. The most difficult and potentially expensive portion of this work is the excavation of a trench through the 45 to 50 feet of limestone to the base of the aquifer. Once the trench is open, any type of impermeable liner can be placed in the trench to produce the desired cutoff effect (except for a bentonite slurry wall which would not be feasible due to the cavernous nature of the limestone).

Since the cost of blasting a trench to this depth for such a great length is prohibitive, some type of rock excavating machinery would have to be used. Although the technology for this type of excavation currently exists, the cost for this type of equipment is extremely variable. Estimates from various contractors involved with this type of work range from $15 to $20 per square foot of wall placed. However, all of the contractors contacted during this study stated that trenches have not been excavated to the depths required by this project in rock materials.

The Little Rock District has recently attempted to use some of these trenching technologies to excavate rock at Beaver Dam. The first contractor tried using a trenching excavator but defaulted on the contract due to poor production rates. The second contractor is currently drilling the trench using a large diameter drill bit, but production is slow and he has already filed a claim against the Government. The final cost of the wall is expected to be about $150 per square foot of installed wall, not including claims.

10. <u>Future Subsurface Investigations</u>. A subsurface investigation will be performed during the detailed design phase to supplement existing data. A minimum of two holes per pump station and one hole per culvert structure will be obtained. Core borings will be acquired where needed for the proposed canals and levees.

C-111
GENERAL REEVALUATION REPORT
Appendix B
Geotechnical Investigations

CORE BORING LOGS

Appendix B
Geotechnical Investigations

CORE BORING LOGS

Structure	Hole Number
S-332	CB-S332-7 CB-S332-8 CB-S332-9 CB-S332-10 CB-S332-11
S-174	CB-1 CB-2 CB-3
S-175	CB-S175-1 CB-S175-2 CB-S175-3
S-18C	CB-S18C-1 CB-S18C-2 CB-S18C-3 CB-S18C-4

26
13

Hole No. CB-S332-7

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 2 SHEETS

1. PROJECT: C&SF Structure 332
2. LOCATION (Coordinates or Station): Sta. ~~280+74.16~~, Rge. ~~1110~~ X 633,117 Y 395,631
3. DRILLING AGENCY: Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number): CB-S332-7
5. NAME OF DRILLER: C. Mason & R. Randall
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 34.7'
10. SIZE AND TYPE OF BIT: See Remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40-C
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES: 3
15. ELEVATION GROUND WATER: +2.3
16. DATE HOLE: STARTED 6-27-74 | COMPLETED 6-28-74
17. ELEVATION TOP OF HOLE: +4.1
18. TOTAL CORE RECOVERY FOR BORING: 85 %
19. ~~SIGNATURE OF INSPECTOR~~ GEOLOGIST: T. NOVAK

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL
+4.1	0.0					+4.1 Bls/0.5 ft
			SILT, soft, calcareous, gray (ML)	30	1	SPLIT SPOON Pushed Pushed 55
+2.9	1.2					+2.6
			LIMESTONE, hard, porous, open solution holes, fossiliferous, buff to gray with yellow stains	100		DIAMOND 4 x 5-1/2 D.T. 23 min. H.P. 75 psi.
						+0.4
				96		" " " DIAMOND 4 x 5-1/2 D.T. 15 min. H.P. 75 psi.
						-1.4
				100		" " " DIAMOND 4 x 5-1/2 D.T. 25 min. H.P. 75 psi.
						-6.4
				100		DIAMOND 4 x 5-1/2 D.T. 35 min. H.P. 75 psi.
						-11.4

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE: +4.1 | **Hole No.** CB-S332-7

PROJECT: C&SF Structure 332 | INSTALLATION: Jacksonville District | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	[redacted] SAMPLE NO f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
						BIT OR BARREL -11.4 Bls/0.5 ft	
				100		DIAMOND 4 x 5-1/2 D.T. 35 min. H.P. 75 psi. -16.4	
-20.4	24.5		Open solution holes from -18.9 to -20.2	100		DIAMOND 4 x 5-1/2 D.T. 17 min. H.P. 75 psi. -20.4	
			Medium hard from -20.4 to -25.6	53		SPLIT SPOON -21.9	3 3 9
				82		" " -23.4	8 15 23
				86		" " -24.9	21 33 23
-25.6	29.7			74		" " -25.6	8 50
-30.6	34.7			100		DIAMOND 4 x 5-1/2 D.T. 45 min. H.P. 75 psi. -30.6	
			NOTES: 1. Set 6" casing to -24.9 2. Hole grouted upon completion with 7 bags of Sakrete.			140# hammer with 30" drop used on 2.0' split spoon (1-3/8" I.D. X 2" O.D.)	

28 15

Hole No. CB-S332-8

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 2 SHEETS

1. PROJECT: C&SF Structure 332	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): Sta. 280+44.16, Rge. 1150 X 635,083 Y 396,986	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40-C
4. HOLE NO. (As shown on drawing title and file number): CB-S332-8	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED: — UNDISTURBED: —
5. NAME OF DRILLER: C. Mason	14. TOTAL NUMBER CORE BOXES: 4
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: +3.8
	16. DATE HOLE: STARTED 7-1-74 COMPLETED 7-2-74
	17. ELEVATION TOP OF HOLE: +4.1
7. THICKNESS OF OVERBURDEN	18. TOTAL CORE RECOVERY FOR BORING: 92.5 %
8. DEPTH DRILLED INTO ROCK	19. ~~XXXXXXXXXXXXXXXX~~ GEOLOGIST: T. NOVAK
9. TOTAL DEPTH OF HOLE: 35.0'	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL
+4.1	0.0					+4.1 Bls/0.5 ft
+2.8	1.3		SILT, soft, calcareous, gray (ML)	40	1	SPLIT SPOON Pushed +2.6 43
			LIMESTONE, hard, porous, solution holes, fossiliferous slightly weathered, buff with yellow stains	100		DIAMOND 4 x 5-1/2 D.T. 13 min. H.P. 75 psi. +0.6
				100		DIAMOND 4 x 5-1/2 D.T. 15 min. H.P. 75 psi. -1.4
				100		DIAMOND 4 x 5-1/2 D.T. 25 min. H.P. 75 psi. -6.4
				100		DIAMOND 4 x 5-1/2 D.T. 35 min. H.P. 75 psi. -11.4

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE +4.1 **Hole No.** CB-S332-8

PROJECT C&SF Structure 332 | INSTALLATION Jacksonville District | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	[redacted] SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL -11.4
				100		DIAMOND 4 x 5-1/2 D.T. 37 min. H.P. 75 psi. -16.4
				98		DIAMOND 4 x 5-1/2 D.T. 16 min. H.P. 75 psi. -21.3
			zones of open solution holes and badly broken from -21.3 to -26.3	95		DIAMOND 4 x 5-1/2 D.T. 28 min. H.P. 75 psi. -26.3
-30.9	35.0			100		DIAMOND 4 x 5-1/2 D.T. 43 min. H.P. 75 psi. -30.9
			NOTE: 1. Hole grouted upon completion.			140# hammer with 30" drop used on 2.0' split spoon (1-3/8" I.D. X 2" O.D.)

Hole No. CB-S332-9

DRILLING LOG

DIVISION	South Atlantic
INSTALLATION	Jacksonville District
SHEET	1 OF 2 SHEETS
1. PROJECT	C&SF Structure 332
2. LOCATION (Coordinates or Station)	Sta. ~~280+44.16~~, Rge. 1110 X 637 725 Y 995 600
3. DRILLING AGENCY	Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number)	CB-S332-9
5. NAME OF DRILLER	F. Crawford
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	34.0'
10. SIZE AND TYPE OF BIT	See Remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	MSL
12. MANUFACTURER'S DESIGNATION OF DRILL	Sprague & Henwood 40-C
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED: — UNDISTURBED: —
14. TOTAL NUMBER CORE BOXES	2
15. ELEVATION GROUND WATER	+3.6
16. DATE HOLE	STARTED 7-3-74 COMPLETED 7-8-74
17. ELEVATION TOP OF HOLE	+3.7
18. TOTAL CORE RECOVERY FOR BORING	51.7 %
19.	GEOLOGIST: T. NOVAK

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL
+3.7	0.0					+3.7 Bls/0.5 ft
+2.5	1.2		SILT, soft, calcareous, gray (ML)	45	1	SPLIT SPOON Pushed Pushed 46 +2.2
			LIMESTONE, hard, porous, solution holes, fossiliferous buff with yellow stains	30		DIAMOND NX D.T. 13 min. H.P. 75 psi. +0.2
				17		DIAMOND NX D.T. 18 min. H.P. 75 psi. -2.8
				8		DIAMOND NX D.T. 46 min. H.P. 75 psi. -7.8
				40		DIAMOND NX D.T. 16 min. H.P. 75 psi. -10.3

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PROJECT: C&SF Structure 332 HOLE NO. CB-S332-9

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE +3.7	Hole No. CB-S332-9
PROJECT C&SF Structure 332	INSTALLATION Jacksonville District	SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL -10.3 Bls/0.5 ft
			contains broken medium hard zones from -10.3 to -12.0	100		DIAMOND 4x5-1/2 D.T. 46 min. H.P. 75 psi. -15.3
				98		DIAMOND 4 x 5-1/2 D.T. 23 min. H.P. 75 psi. -20.3
				28		DIAMOND 4 x 5-1/2 D.T. 1 Hr. 2 min. H.P. 75 psi. -23.8
				56		SPLIT SPOON 5 / 47 / 7 -25.3
		CAVITY	void from -25.2 to -25.8	47		" " 2 / 67 -26.3
-30.3	34.0			100		DIAMOND 4 x 5-1/2 D.T. 30 min. H.P. 75 psi. -30.3
			NOTE: 1. Hole grouted upon completion with 7 bags of Sakrete.			140# hammer with 30" drop used on 2.0' split spoon (1-3/8" ID. X 2" O.D.)

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PROJECT	HOLE NO
C&SF Structure 332	CB-S332-9

Hole No. CB-S332-10

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 2 SHEETS

1. PROJECT: C&SF Structure 332	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): Sta. 280+74.16, Rge. 1150.42 X 635,078 Y 895,618	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40-C
4. HOLE NO. (As shown on drawing title and file number): CB-S332-10	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: F. Crawford	14. TOTAL NUMBER CORE BOXES: 4
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ___ DEG. FROM VERT.	15. ELEVATION GROUND WATER: +3.8
	16. DATE HOLE: STARTED 7-11-74; COMPLETED 7-12-74
	17. ELEVATION TOP OF HOLE: +3.8
7. THICKNESS OF OVERBURDEN	18. TOTAL CORE RECOVERY FOR BORING: 89.2 %
8. DEPTH DRILLED INTO ROCK	19. ~~XXXXXXXXXXXXXXX~~ GEOLOGIST: T. NOVAK
9. TOTAL DEPTH OF HOLE: 33.0'	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL
+3.8	0.0					+3.8 Bls/0.5 ft
			SILT, soft, calcareous, gray (ML)	40	1	SPLIT SPOON Pushed Pushed
+2.3	1.5					+2.3 Pushed
			LIMESTONE, hard, porous, fossiliferous, solution holes buff to light gray	90		DIAMOND 4 x 5-1/2 D.T. 14 min. H.P. 75 psi.
						+0.3
				100		DIAMOND 4 x 5-1/2 D.T. 43 min. H.P. 75 psi.
						-4.7
				100		DIAMOND 4 x 5-1/2 D.T. 40 min. H.P. 75 psi.
						-9.2

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE +3.8 **Hole No.** CB-S332-10

PROJECT: C&SF Structure 332 | INSTALLATION: Jacksonville District | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL -9.2
				92		DIAMOND 4 x 5-1/2 D.T. 50 min. H.P. 75 psi. -14.2
				100		DIAMOND 4 x 5-1/2 D.T. 45 min. H.P. 75 psi. -19.2
			Open solution holes with poorly cemented zones from -21.7 to -25.7	98		DIAMOND 4 x 5-1/2 D.T. 55 min. H.P. 75 psi. -24.2
-29.2	33.0			94		DIAMOND 4 x 5-1/2 D.T. 50 min. H.P. 75 psi. -29.2
			NOTE: 1. Hole grouted upon completion with 7 bags of Sakrete.			140# hammer with 30" drop used on 2.0' split spoon (1-3/8" I.D. X 2" O.D.)

Hole No. CB-S332-11

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 2 SHEETS

1. PROJECT: C&SF Structure 332
2. LOCATION (Coordinates or Station): ~~Sta. 280+59, Rge. 1130~~ X 638 101 Y 395 613
3. DRILLING AGENCY: Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number): CB-S332-11
5. NAME OF DRILLER: F. Crawford
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 31.5'
10. SIZE AND TYPE OF BIT: See Remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40-C
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES: 0
15. ELEVATION GROUND WATER: +4.4
16. DATE HOLE: STARTED 7-15-74 | COMPLETED 7-17-74
17. ELEVATION TOP OF HOLE: +4.0
18. TOTAL CORE RECOVERY FOR BORING: Not Attempted
19. ~~SIGNATURE OF INSPECTOR~~ GEOLOGIST: T. NOVAK

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	[redacted]	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) e
			Recharge Tests; GPM/Ft. Head		BIT OR BARREL
+4.0	0.0				+4.0 Bls/0.5 ft
			SILT, (ML)		SPLIT SPOON Pushed
+2.7	1.3				+2.5 26
			LIMESTONE, hard, porous, solution holes, fossiliferous, buff to gray.		DIAMOND NX D.T. 10 min. H.P. 75 psi.
					+0.5
			NOTE: Core recovery was not attempted; therefore, a detailed description is not available.	*	DIAMOND NX D.T. 23 min. H.P. 75 psi.
					-2.5
				*	DIAMOND NX D.T. 40 min. H.P. 75 psi.
					-7.5
				*	DIAMOND NX D.T. 40 min. H.P. 75 psi.
					-12.5

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE +4.0 **Hole No.** CB-S332-11

PROJECT C&SF Structure 332 | INSTALLATION Jacksonville District | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	[redacted]		REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL -12.5
					*	DIAMOND NX D.T. 46 min. H.P. 75 psi. -17.5
					*	DIAMOND NX D.T. 40 min. H.P. 75 psi. -22.5
-27.5	31.5				*	DIAMOND NX D.T. 45 min. H.P. 75 psi. -27.5
			NOTES: 1. No core recovery was attempted. 2. NX casing set to -22.5 3. *No head could be maintained with pump operating at maximum capacity (50 GPM)			140# hammer with 30" drop used on 2.0' split spoon (1-3/8" I.D. X 2" O.D.)

Hole No. CB-1

DRILLING LOG

DIVISION	South Atlantic
INSTALLATION	Jacksonville District
SHEET	1 OF 1 SHEETS
1. PROJECT	C&SF Structure 174
2. LOCATION (Coordinates or Station)	
3. DRILLING AGENCY	Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number)	CB-1
5. NAME OF DRILLER	D. L. Loadholtz
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	37.0
10. SIZE AND TYPE OF BIT	See Remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	MSL
12. MANUFACTURER'S DESIGNATION OF DRILL	Sprague & Henwood 40C
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED: UNDISTURBED:
14. TOTAL NUMBER CORE BOXES	1
15. ELEVATION GROUND WATER	+3.5
16. DATE HOLE	STARTED 12/14/65 COMPLETED 12/15/65
17. ELEVATION TOP OF HOLE	+6.2
18. TOTAL CORE RECOVERY FOR BORING	74 %
19. ~~SIGNATURE OF INSPECTOR~~ Geologist	G. J. Kraynak

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Recharge Test GPN/Ft. head			Bit & Barrel Bls/Ft
+6.2	0.0					+6.2
			LIMESTONE, medium hard, white to buff, with silt in voids & solution channels	100		2" I.D.SPOON 42, 24, 22, 26, 28; +1.2
				100	0.7	" " 24, 23, 27, 28, 40; -3.8
				95	*	" " 28, 23, 119, 26, 33; -8.8
				45	*	" " 27, 22, 25, 5, 41; -13.8
-13.8	20.0		LIMESTONE, hard, dense, buff fossiliferous, with occasional solution channels	95	*	DIAMOND NX; -15.8
-15.8	22.0		LIMESTONE, medium hard, light gray with silt in voids & solution channels	100		2" I.D.SPOON 107, 27, 26; -18.8
				100		-19.8 " " 78
-20.3	26.5		LIMESTONE, hard, slightly dense, fossiliferous, light gray, with occasional solution channels	50	*	DIAMOND NX; -23.8
				40	*	DIAMOND NX; -25.8
-25.8	32.0		PROBABLY silt filled cavity	0		-27.8 Pushed Core Barrel
-27.8	34.0	C	LIMESTONE, hard, dark gray, dense, fossiliferous, with occasional solution channels	87	*	DIAMOND NX; -30.8
-30.8	37.0		*Raised no head with pump operating at 30 GPM			300# Hammer with 18" drop used on 2" I.D.SPOON. Grouted with 4 bags sakrete

ENG FORM 1 APR 63 1836 PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801)

PROJECT C&SF Structure 174 HOLE NO. CB-1

Hole No. CB-2

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 1 SHEETS
1. PROJECT C&SF Structure 174		10. SIZE AND TYPE OF BIT See Remarks	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY Corps of Engineers		12. MANUFACTURER'S DESIGNATION OF DRILL Sprague & Henwood 40C	
4. HOLE NO. (As shown on drawing title and file number)	CB-2	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER D. L. Loadholtz		14. TOTAL NUMBER CORE BOXES 2	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.		15. ELEVATION GROUND WATER +3.1	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE	STARTED 12/15/65 / COMPLETED 12/16/65
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE +6.1	
9. TOTAL DEPTH OF HOLE 36.5		18. TOTAL CORE RECOVERY FOR BORING 71 %	
		19. Geologist G. J. Kraynak	

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)	Bls/Ft
			Recharge Test GPM/Ft. head			Bit & Barrel	Bls/Ft
+6.1	0.0					+6.1	
			LIMESTONE, Medium hard, white with silt in voids & solution channels, hard in thin layers	90		2" I.D.SPOON	45, 26, 25, 25
						+1.1	28
				90	2.8	" "	30, 30, 28, 40
						-3.9	33
				70	*	" "	32, 34, 224, 53
						-8.9	77
				90	*	" "	64, 45, 42
-12.9	19.0					-12.9	45
			LIMESTONE, hard, dense, light gray, slightly fossiliferous with occasional solution channels	60	4.5	DIAMOND NX	
						-17.9	
-19.4	25.5			50		" " -19.4	
			LIMESTONE, medium hard white, fossiliferous with silt in voids & solution channels, hard in thin layers	90	6.0	2" I.D.SPOON	92, 34, 75
-23.4	29.5					-23.4	30
			LIMESTONE, hard, dark gray dense, fossiliferous, with occasional solution channels	25	*	DIAMOND NX	
						-28.4	
-30.4	36.5			85		" " -30.4	
			*Raised no head with pump operating at 30 GPM			300# Hammer with 18" drop used on 2" I.D. SPOON Grouted with 4 bags sakrete	

Hole No. CB-3

DRILLING LOG

Division	South Atlantic
Installation	Jacksonville District
Sheet	1 of 1 sheets
1. Project	C&SF, Structure 174
2. Location (Coordinates or Station)	
3. Drilling Agency	Corps of Engineers
4. Hole No. (As shown on drawing title and file number)	CB-3
5. Name of Driller	D. L. Loadholtz
6. Direction of Hole	☒ Vertical ☐ Inclined ____ Deg. from Vert.
7. Thickness of Overburden	
8. Depth Drilled into Rock	
9. Total Depth of Hole	37.8
10. Size and Type of Bit	See remarks
11. Datum for Elevation Shown (TBM or MSL)	MSL
12. Manufacturer's Designation of Drill	Sprague and Henwood 40C
13. Total No. of Overburden Samples Taken	Disturbed: — Undisturbed: —
14. Total Number Core Boxes	1
15. Elevation Ground Water	+3.2
16. Date Hole	Started 12/17/65 Completed 12/20/65
17. Elevation Top of Hole	+6.4
18. Total Core Recovery for Boring	52%
19. Geologist	G. J. Kraynak

Elevation	Depth	Classification of Materials (Description)	% Core Recovery	Recharge Tests; GPM/Ft. Head	Remarks (Bit & Barrel)	Bls/Ft
+6.4	0.0	LIMESTONE, medium hard, white, fossiliferous, with silt in voids and solution channels	90		+6.4 2" I.D. Spoon	48, 40, 35, 28, 30
			100	0.84	+1.4 " "	46, 36, 38, 41, 42
			60	*	-3.6 " "	30, 30, 61, 68, 31
			70	4.5	-8.6 " "	51, 55, 53, 16, 55
-19.3	12.9	LIMESTONE, hard, dense, light gray, fossiliferous with occasional solution channels	40	4.5	-12.9 DIAMOND NX	
			36	*	-17.9 DIAMOND NX	
			23	*	-22.9 DIAMOND NX	
-24.4	30.8	NO RECOVERY, probably medium hard limestone	0	*	-24.9 2" I.D. Spoon	6, 30
-26.4	32.8	LIMESTONE, hard, dense, dark gray, fossiliferous with occasional solution channels	50	*	-26.4 DIAMOND NX	
-31.4	37.8				-31.4	

*Raised no head with pump operating at 30 GPM

Hole grouted upon completion

300# Hammer with 18" Drop used on 2" I.D. Spoon

Hole No. CB-S 175-1

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 2 SHEETS
1. PROJECT C&SF STRUCTURE 175		10. SIZE AND TYPE OF BIT see remarks	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY Corps of Engineers		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500	
4. HOLE NO. (As shown on drawing title and file number) CB-S175-1		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER R. Gordon		14. TOTAL NUMBER CORE BOXES 1	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER +4.8	
		16. DATE HOLE	STARTED 10/7/66 COMPLETED 10/10/66
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE +4.9	
8. DEPTH DRILLED INTO ROCK		18. TOTAL CORE RECOVERY FOR BORING 63 %	
9. TOTAL DEPTH OF HOLE 35.1'		19. Geologist: R. Dineen	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e		REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
			RECHARGE TESTS; GPM/Ft.head			BIT & BARREL	Bls/ft.
+4.9	0.0					+4.9	
			LIMESTONE, buff to white, medium hard, oolitic, fossiliferous, solution riddled	88		2" I.D.Spoon	18 39 26 27 22
						-0.1	
				64	"	" "	24 20 16 23 206
						-5.1	
				100	*	" "	55 63 78
-8.1	13.0					-8.1	
			LIMESTONE, buff to white, hard, fossiliferous, lenses of softer limestone, solution riddled	60		DIAMOND NX	
						-10.1	
				10	*	" "	
						-12.1	
				14		" "	
-13.8	18.7					-14.1	
			LIMESTONE, medium hard, buff to white, fossiliferous, lenses of sand below -20.1	100		-15.1 2" I.D.Spoon	8
				75	*	" "	27 21 11 10 29
						-20.1	

ENG FORM 1836 1 APR 63 PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801)

PROJECT C&SF STRUCTURE 175 HOLE NO. CB-S175-1

Hole No. CB-S175-1

DRILLING LOG	DIVISION SOUTH ATLANTIC	INSTALLATION Jacksonville District	SHEET 2 OF 2 SHEETS
1. PROJECT C&SF STRUCTURE 175		10. SIZE AND TYPE OF BIT	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title and file number)	CB-S175-1	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE	STARTED / COMPLETED
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK		18. TOTAL CORE RECOVERY FOR BORING	%
9. TOTAL DEPTH OF HOLE		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e		REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			RECHARGE TESTS; GPM/Ft. Head			BIT & BARREL Bls/ft.
						-20.1
				10	*	2" I.D.Spoon 16 52 124
-22.8	27.7					-22.8
			LIMESTONE, buff to white, hard, fossiliferous, solution riddled, bed of softer sandy limestone from -24.9 to -26.6	81		DIAMOND NX -25.1
				100	*	2" I.D.Spoon 71 101 -26.6
				32		DIAMOND NX -28.1
				48		" " -30.2
-30.2	35.1					

*COULD RAISE NO HEAD WITH PUMP OPERATING AT MAXIMUM CAPACITY OF 36 GPM

HOLE GROUTED UPON COMPLETION

300# Hammer with 18" drop used on 2" I.D. x 2-1/2" O.D. Spoon

Hole No. CB-S175-2

DRILLING LOG

DIVISION	South Atlantic
INSTALLATION	Jacksonville District
SHEET	1 OF 2 SHEETS
1. PROJECT	C&SF STRUCTURE 175
2. LOCATION (Coordinates or Station)	
3. DRILLING AGENCY	Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number)	CB-S175-2
5. NAME OF DRILLER	R. Gordon
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	35.0'
10. SIZE AND TYPE OF BIT	see remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	MSL
12. MANUFACTURER'S DESIGNATION OF DRILL	FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED: — UNDISTURBED: —
14. TOTAL NUMBER CORE BOXES	1
15. ELEVATION GROUND WATER	+5.2
16. DATE HOLE	STARTED 9/30/66 COMPLETED 10/3/66
17. ELEVATION TOP OF HOLE	+5.0'
18. TOTAL CORE RECOVERY FOR BORING	76 %
19. ~~SIGNATURE OF INSPECTOR~~	Geologist: R. Dineen

RECHARGE TESTS; GPM/Ft. head

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e		REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) f
						BIT & BARREL Bls/ft.
+5.0	0.0		LIMESTONE, buff to white, oolitic, fossiliferous, medium hard; weathered from +5.0 to +3.0; sandy from +5.0 to -10.0	92	*	+5.0 2" I.D. Spoon 9, 22, 31, 31, 15; 0.0
				86	*	" " 35, 12, 20, 19, 62; -5.0
				90	*	" " 56, 45, 66, 130; -9.0
-8.5	13.5		hard from -8.5 to -12.3	100		-10.0 DIAMOND NX
-12.3	17.3			40	*	" " -12.5
-13.5	18.5		oolite sand, buff, from -12.3 to -13.5	100		2" I.D. Spoon 18, 36, 56; -15.0
-15.0	20.0					
-16.3	21.3		oolite sand, buff, from -15.0 to -16.3	80	*	" " 31, 20, 12, 5, 1; -20.0
-20.0	25.0					

Hole No. CB-S175-2

DRILLING LOG	DIVISION	INSTALLATION	SHEET 2 OF 2 SHEETS

1. PROJECT		10. SIZE AND TYPE OF BIT	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title and file number)	CB-S175-2	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE	STARTED / COMPLETED
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE	
9. TOTAL DEPTH OF HOLE		18. TOTAL CORE RECOVERY FOR BORING %	
		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e		REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) f
			RECHARGE TESTS; GPM/Ft.Head			BIT & BARREL Bls/ft.
-20.0	25.0					-20.0
-22.5	27.5		oolite sand, buff, from -20.0 to -22.5	100	*	2" I.D.Spoon 39 / 226 / 148 -23.0
			hard from -22.5 to -30.0	21		DIAMOND NX -25.0
				41	*	" " -27.5
-30.0	35.0			62		" " -30.0
			*Could raise no head with pump operating at maximum capacity of 35 GPM HOLE GROUTED UPON COMPLETION			300# Hammer with 18" drop used on 2" I.D. x 2-1/2" O.D. Spoon

ENG FORM 1 APR 63 1836 PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801)

PROJECT	HOLE NO
C&SF STRUCTURE 175	CB-S175-2

Hole No. CB-S175-3

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 2 SHEETS
1. PROJECT C&SF Structure 175		10. SIZE AND TYPE OF BIT see remarks	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY Corps of Engineers		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500	
4. HOLE NO. (As shown on drawing title and file number)	CB-S175-3	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER R. Gordon		14. TOTAL NUMBER CORE BOXES 1	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER +5.2	
		16. DATE HOLE	STARTED 9/26/66 COMPLETED 9/29/66
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE +5.1	
8. DEPTH DRILLED INTO ROCK		18. TOTAL CORE RECOVERY FOR BORING 64 %	
9. TOTAL DEPTH OF HOLE 35.1'		19. [redacted] Geologist: R. Dineen	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	[redacted]	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT & BARREL Bls/ft.
			RECHARGE TESTS; GPM;Ft.head			
+5.1	0.0					+5.1
+4.1	1.0		LIMESTONE,white to buff, oolitic,medium hard,with thin hard streaks,layer of silt, sandy,dark buff,calcareous, from +4.1 to +2.8	90		2" I.D.Spoon 3 18 29 36 34 +0.1
+2.8	2.3					
				76	6.0	" " 24 14 33 28 58 -4.9
				63	6.0	" " 82 37 513 -7.9
				25		DIAMOND NX -9.9
-10.7	15.8					
-12.1	17.2		layr of sand,silty,calcareous, buff (SP) from -10.7 to -12.1 and from -15.1 to -19.3	100	60	2" I.D.Spoon 11 3 426 125 49 -14.9
-15.1	20.2					
				20	1.4	" " 19 8 4 2 30 -19.9
-19.3	24.4					

Hole No. CB-S175-3

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 2 OF 2 SHEETS
1. PROJECT C&SF STRUCTURE 175		10. SIZE AND TYPE OF BIT	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title and file number)	CB-S175-3	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE	STARTED / COMPLETED
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE	
9. TOTAL DEPTH OF HOLE		18. TOTAL CORE RECOVERY FOR BORING %	
		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	[redacted]	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			RECHARGE TESTS: GPM/FT. HEAD			BIT & BARREL Bls/ft.
						-19.9
-21.5	26.6			50	6.0	2" I.D.Spoon 61 54 800 -22.9
			LIMESTONE, hard, white to buff, silty, fossiliferous from -22.9 to -26.9	80		DIAMOND NX -24.9
				85	6.0	" " -26.9
				85		" " -28.4
-30.0	35.1			95		" " -30.0
			HOLE GROUTED UPON COMPLETION			300# Hammer with 18" drop used on 2" I.D. x 2-1/2" O.D. Spoon

HOLE NO. CB-S18C-1

DEPARTMENT OF THE ARMY DIVISION Corps of Engineers INSTALLATION Jacksonville, Florida DRILLING LOG	1. PROJECT C&SF Structure 18C	SHEET 1 OF 1
	2. LOCATION (Coordinates or Station) X=656,808 Y=362,538	
	3. DRILLING AGENCY Corps of Engineers	
4. HOLE NO. (As shown on drawing title and file no.) CB-S18C-1	5. NAME OF DRILLER C. R. Mason	
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED — DEGREES WITH VERTICAL	7. THICKNESS OF OVERBURDEN / 8. DEPTH DRILLED INTO ROCK	9. TOTAL DEPTH OF HOLE 39'
10. SIZE AND TYPE OF BIT See remarks / 11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	12. MANUFACTURER'S DESIGNATION OF DRILL Sprague & Henwood 40C	
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED — UNDISTURBED — / 14. TOTAL NO. CORE BOXES 2	15. ELEV. GROUND WATER +2.0 / 16. DATE HOLE STARTED 12/10/63 COMPLETED 12/10/63	
17. ELEV. TOP OF HOLE 0.0 / 18. TOTAL CORE RECOVERY FOR BORING (%) 78	19. ~~SIGNATURE OF INSPECTOR~~ Geologist Robert G. Kretchman	

ELEVATION	DEPTH	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)	Bls/Ft
					Bit & Barrel	Bls/Ft
0.0	0.0				0.0	
		LIMESTONE, medium hard, light gray, sandy, fossiliferous, porous, friable, solution holes, layers of hard limestone from -6.6 to -8.0 and from -10.5 to -13.0	70		2" I.D. Spoon -3.0	6 / 8 / 12
			70		" " -6.6	15 / 25 / 25 / 54
			57		NX Diamond -8.0	
			92		2" I.D. Spoon -10.5	48 / 67 / 74
			24		NX Diamond -13.0	
-15.0	15.0		79		2" I.D. Spoon -17.3	21 / 11 / 106 / 127 / 100
		LIMESTONE, hard, light gray, fossiliferous, porous, friable solution holes	50		-18.0 NX Diamond	
			90		" " -20.0	
			84		" " -22.5	
			84		" " -25.0	
			100		" " -27.5	
			100		" " -30.0	
			100		" " -32.0	
-34.0	34.0		60		" " -34.0	
		LIMESTONE, medium hard, light gray, sandy, fossiliferous, porous, friable, solution holes	80		2" I.D. Spoon	20 / 20 / 50 / 48 / 12
-39.0	39.0				-39.0	
					300# Hammer w/18" Drop Used on 2" I.D. Spoon	

HOLE NO. CB-S18C-2

DEPARTMENT OF THE ARMY

DIVISION Corps of Engineers

INSTALLATION Jacksonville, Florida

DRILLING LOG

1. PROJECT: C&SF Structure 18C	SHEET 1 OF 2
2. LOCATION (Coordinates or Station): X=656,848 Y=362,540	
3. DRILLING AGENCY: Corps of Engineers	
4. HOLE NO. (As shown on drawing title and file no.): CB-S18C-2	5. NAME OF DRILLER: G. M. Lineberger
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED — DEGREES WITH VERTICAL	7. THICKNESS OF OVERBURDEN — 8. DEPTH DRILLED INTO ROCK — 9. TOTAL DEPTH OF HOLE 53.7'
10. SIZE AND TYPE OF BIT: See remarks	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL — 12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40C
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED — UNDISTURBED	14. TOTAL NO. CORE BOXES 2 — 15. ELEV. GROUND WATER +2.0 — 16. DATE HOLE: STARTED 12/2/63, COMPLETED 12/4/63
17. ELEV. TOP OF HOLE: +0.7	18. TOTAL CORE RECOVERY FOR BORING (%): 62 — 19. ~~SIGNATURE OF INSPECTOR~~ Geologist: Robert G. Kretchman

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	[redacted]	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
						Bit & Barrel Bls/Ft
+0.7	0.0					+0.7
			LIMESTONE, hard, light gray, sandy, fossiliferous, porous, friable, solution holes	50		NX Diamond -2.0
				10		-3.0 " "
				35	6.40	" " -5.5
				50		" " -8.0
				45		" " -10.5
				90	3.20	" " -13.0
-14.0	14.7			100		-14.0 " "
			Layer of medium hard limestone from -14.0 to -19.0	25	7.44	2" I.D. Spoon -18.0 — 20, 20, 70, 73
-19.0	19.7			50		" " -20.0 — 90, 170
				87	10.70	NX Diamond -23.0
				No Rec.		-23.8 2" I.D. Spoon 87
				100		NX Diamond -25.6
				100	10.70	" " -28.0
				100		" " -30.8
				100	0.625	" " -33.0

HOLE NO. CB-S18C-2

DEPARTMENT OF THE ARMY DIVISION Corps of Engineers INSTALLATION Jacksonville, Florida DRILLING LOG	1. PROJECT C&SF Structure 18C	SHEET 2 OF 2
4. HOLE NO. (As shown on drawing title and file no.)	2. LOCATION (Coordinates or Station)	
6. DIRECTION OF HOLE: VERTICAL / INCLINED / DEGREES WITH VERTICAL	3. DRILLING AGENCY	
10. SIZE AND TYPE OF BIT	5. NAME OF DRILLER	
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	7. THICKNESS OF OVERBURDEN / 8. DEPTH DRILLED INTO ROCK / 9. TOTAL DEPTH OF HOLE	
12. MANUFACTURER'S DESIGNATION OF DRILL		
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED	14. TOTAL NO. CORE BOXES / 15. ELEV. GROUND WATER	16. DATE HOLE: STARTED / COMPLETED
17. ELEV. TOP OF HOLE	18. TOTAL CORE RECOVERY FOR BORING (%)	19. SIGNATURE OF INSPECTOR

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY		REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)	Bls/Ft
						Bit & Barrel	Bls/Ft
						-33.0	
				15		NX Diamond	
					7.44	-35.5	
				30		" "	
-38.0	38.7					-38.0	
			LIMESTONE, medium hard, light gray, sandy, fossiliferous, porous, friable, solution holes	70	32.00	2" I.D."Spoon	8 9 7 44 34
						-43.0	
				70	*	" "	27 24 19 44 47
-48.0	48.7					-48.0	
			SAND, medium to fine, quartz, light gray (SP)	80	4.60	" "	11 15 33 21 10
-53.0	53.7					-53.0	
			*Raised no head with pump operating at full capacity of 32 g.p.m.			300# Hammer w/18" Drop Used on 2" I.D. Spoon	

HOLE NO. CB-S18-C-3

DEPARTMENT OF THE ARMY

DIVISION Corps of Engineers'

INSTALLATION Jacksonville, Florida

DRILLING LOG

1. PROJECT	C&SF Structure 18C
SHEET	1 OF 1
2. LOCATION (Coordinates or Station)	X = 656,810 Y: 362,509
3. DRILLING AGENCY	Corps of Engineers
4. HOLE NO. (As shown on drawing title and file no.)	CB-S18-C-3
5. NAME OF DRILLER	G. M. Lineberger
6. DIRECTION OF HOLE	☑ VERTICAL ☐ INCLINED ___ DEGREES WITH VERTICAL
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	40.6'
10. SIZE AND TYPE OF BIT	See remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	MSL
12. MANUFACTURER'S DESIGNATION OF DRILL	Sprague & Henwood 40C
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED - UNDISTURBED
14. TOTAL NO. CORE BOXES	2
15. ELEV. GROUND WATER	+2.0
16. DATE HOLE	STARTED 12/6/63 COMPLETED 12/9/63
17. ELEV. TOP OF HOLE	+1.6
18. TOTAL CORE RECOVERY FOR BORING (%)	74
19. ~~SIGNATURE OF INSPECTOR~~ Geologist	Robert G. Kretchman

ELEVATION	DEPTH	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)	Bls/Ft
					Bit & Barrel	Bls/Ft
+1.6	0.0				+1.6	
		PEAT, brown, very silty (PT)	100	1	2" I.D. Spoon	Pushed
-0.4	2.0				-0.4	
		LIMESTONE, medium hard, light gray, sandy, fossiliferous, porous, friable, solution holes	75		" " -3.4	12, 17, 23
			82		" " -8.4	15, 18, 75, 70, 74
-10.4	12.0	Layer of hard limestone from -10.4 to -13.4	60		" " -10.4	80, 81
			45		NX Diamond -13.4	
-13.4	15.0		50		" " 2" I.D. Spoon -18.4	40, 17, 41, 53, 90
-18.4	20.0	LIMESTONE, hard, light gray, sandy, fossiliferous, porous, friable, solution holes	88		NX Diamond -20.9	
			96		" " -23.4	
			72		" " -25.9	
			100		" " -28.5	
			65		" " -30.9	
			50		" " -34.0	
-34.0	35.6	LIMESTONE: medium hard, light gray, sandy, fossiliferous, porous, friable, solution holes	90		2" I.D. Spoon -39.0	25, 54, 33, 17, 7
-39.0	40.6					

300# Hammer w/18" Drop Used on 2" I.D. Spoon

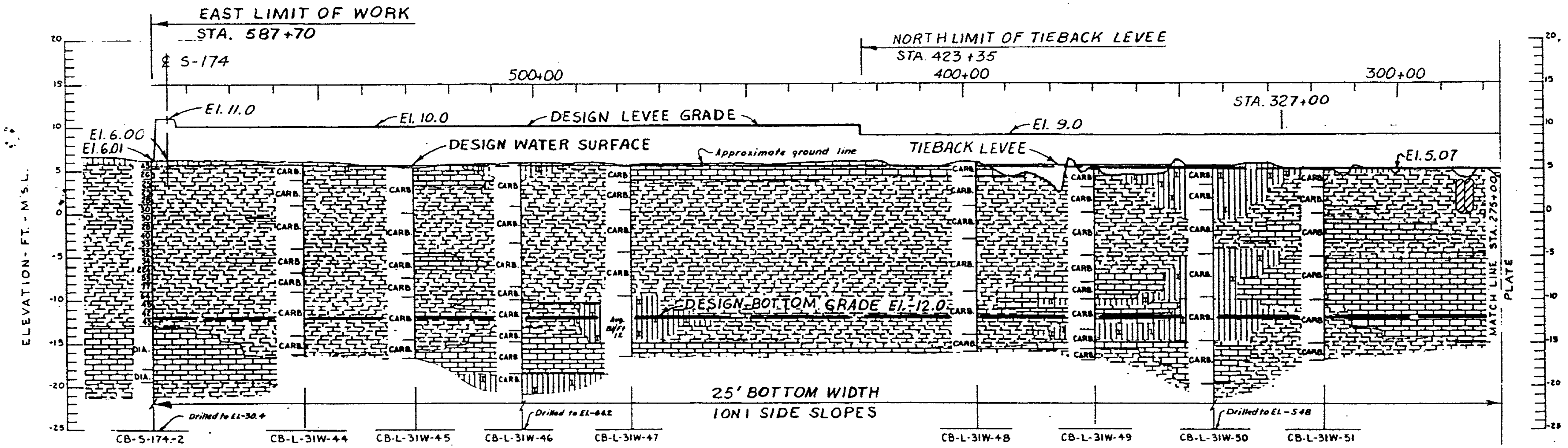
HOLE NO. CB-S18C-4

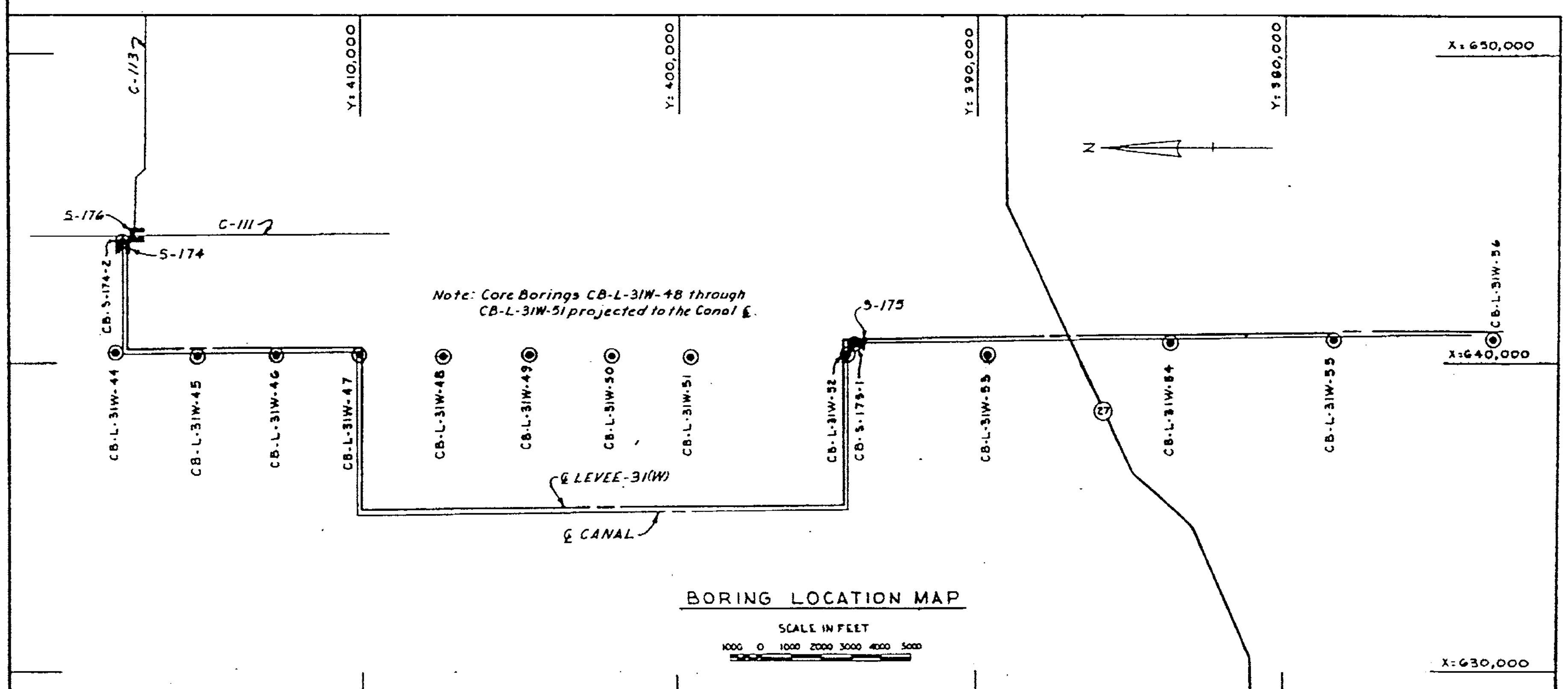
DEPARTMENT OF THE ARMY	1. PROJECT	SHEET 1 OF 1
DIVISION Corps of Engineers INSTALLATION Jacksonville, Florida	C&SF Structure 18C	
DRILLING LOG	2. LOCATION (Coordinates or Station) X=656,850 Y=362,510	
	3. DRILLING AGENCY Corps of Engineers	
4. HOLE NO. (As shown on drawing title and file no.) CB-S18C-4	5. NAME OF DRILLER G. M. Lineberger	
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED, DEGREES WITH VERTICAL	7. THICKNESS OF OVERBURDEN / 8. DEPTH DRILLED INTO ROCK	9. TOTAL DEPTH OF HOLE 42.5'
10. SIZE AND TYPE OF BIT See remarks / 11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	12. MANUFACTURER'S DESIGNATION OF DRILL Sprague & Henwood 40C	
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED - UNDISTURBED / 14. TOTAL NO. CORE BOXES 2	15. ELEV. GROUND WATER +2.0 / 16. DATE HOLE STARTED 12/4/63	COMPLETED 12/5/63
17. ELEV. TOP OF HOLE +2.0 / 18. TOTAL CORE RECOVERY FOR BORING (%) 75	19. ~~SIGNATURE OF INSPECTOR~~ Geologist Robert G. Kretchman	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)	Bls/Ft
						Bit & Barrel	Bls/Ft
+2.0	0.0					+2.0	
+0.7	1.3		PEAT, dark brown, very silty (PT)		1	2" I.D. Spoon	Pushed
			LIMESTONE, medium hard, light gray, sandy, fossiliferous, porous, friable, solution holes	100			48 / 80 / 15 / 14
						-3.0	
				75		" "	10 / 36 / 25 / 45
			Layer of hard limestone from -6.8 to -8.0	50		-6.8 NX Diamond	
				45		-8.0 2" I.D. Spoon	20 / 23
-9.8	11.8					-9.8 NX Diamond	
			LIMESTONE, hard, light gray, sandy, fossiliferous, porous, friable, solution holes, layer of medium hard limestone from -13.0 to -15.0	63			
						-13.0	
				50		2" I.D. Spoon	48 / 15
						-15.0	
				60		NX Diamond	
						-18.0	
				82		" "	
						-21.0	
				85		" "	
						-23.0	
				60		" "	
						-25.5	
				100		" "	
						-28.0	
				100		" "	
						-30.5	
				100		" "	
						-33.0	
				50		" "	
-35.5	37.5					-35.5	
			LIMESTONE, medium hard, light gray, sandy, fossiliferous, porous, friable	80		2" I.D. Spoon	21 / 20 / 6 / 9 / 15
-40.5	42.5					-40.5	
						300# Hammer w/18" Drop Used on 2" I.D. Spoon	

C-111
GENERAL REEVALUATION REPORT
Appendix B
Geotechnical Investigations

PLATES





TIEBACK LEVEE DESIGN GRADE:

STA. 210+00 to 265+00 – El. 5.5

STA. 265+00 to 327+00 – El. 4.5

STA. 327+00 to 423+35 – El. 5.5

SEE PLATE B-2 FOR LEGEND

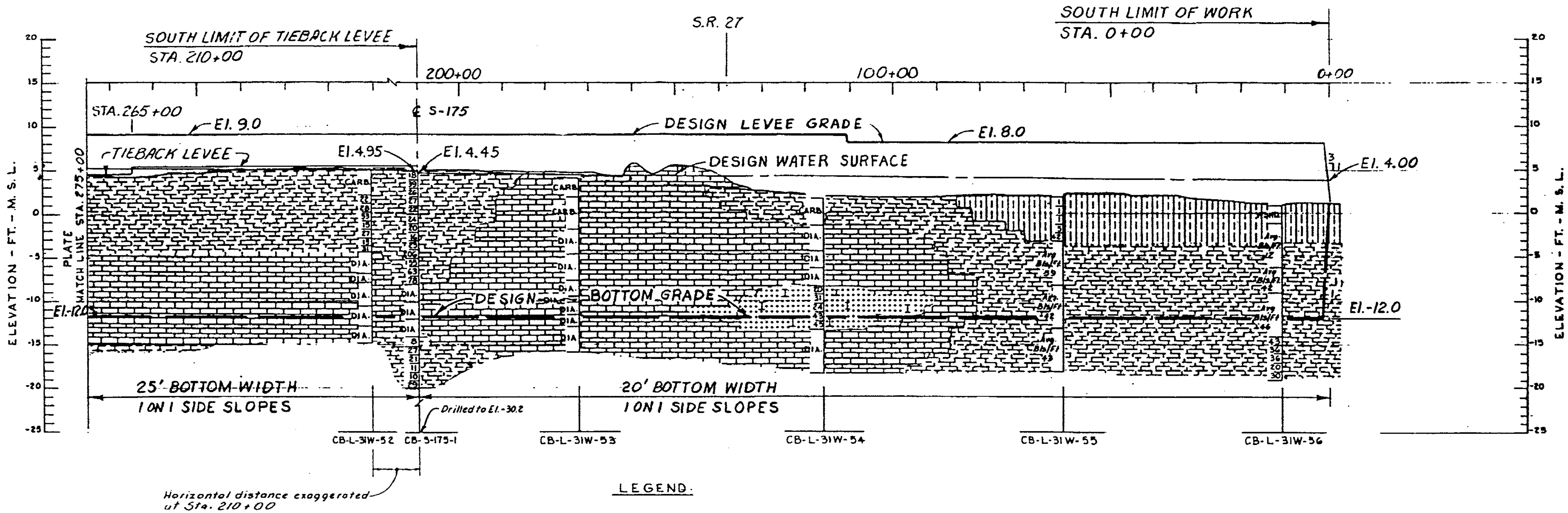
CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL 111
GENERAL REEVALUATION REPORT

LEVEE 31W
GEOLOGIC SECTION

SCALES AS SHOWN

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: DECEMBER 1993 D.O. FILE NO. 498-36,553



LEGEND.

- LIMESTONE FRAGMENTS, USED IN COMBINATION WITH OTHER SYMBOLS
- SAND, FINE TO COARSE, QUARTZ AND CALCITE, CONTAINS NUMEROUS LIMESTONE FRAGMENTS, COMPACT (SP)
- SILT, ORGANIC (OH)
- SILT, INORGANIC, GENERALLY SEMI INDURATED EXCEPT AT SURFACE, OCCASIONALLY CONTAINS LIMESTONE FRAGMENTS (ML)
- LIMESTONE, MEDIUM HARD, GENERALLY SILTY FROM CB-L31W-44 THROUGH CB-L31W-51. GENERALLY OOLITIC CB-L31-52 THROUGH CB-L31-56
- LIMESTONE, HARD, POROUS TO DENSE
- 22 / 28 / 53 / 15 / 27 — NUMBER OF HAMMER BLOWS REQUIRED TO ADVANCE A SOLID SPOON SAMPLER (2" I.D. X 2 1/2" O.D.) ONE FOOT USING A 300 POUND HAMMER FALLING 18 INCHES. THE SPOON IS 5 FT. LONG AND DRIVEN CONTINUOUSLY 5 FT., WHERE POSSIBLE.
- Avg Bb/Ft 43 — AVERAGE BLOWS PER FOOT FOR EACH FOOT OF ENTIRE RUN
- WSHD — WASHED AHEAD OF CASING
- CARB — DRILLED WITH CARBIDE TIPPED BIT
- DIA — DRILLED WITH DIAMOND BIT

PIPE DIA. CULVERT

CANAL SIDE INVERT

Note: See Plate 1 for Location map.

SCALE IN FEET

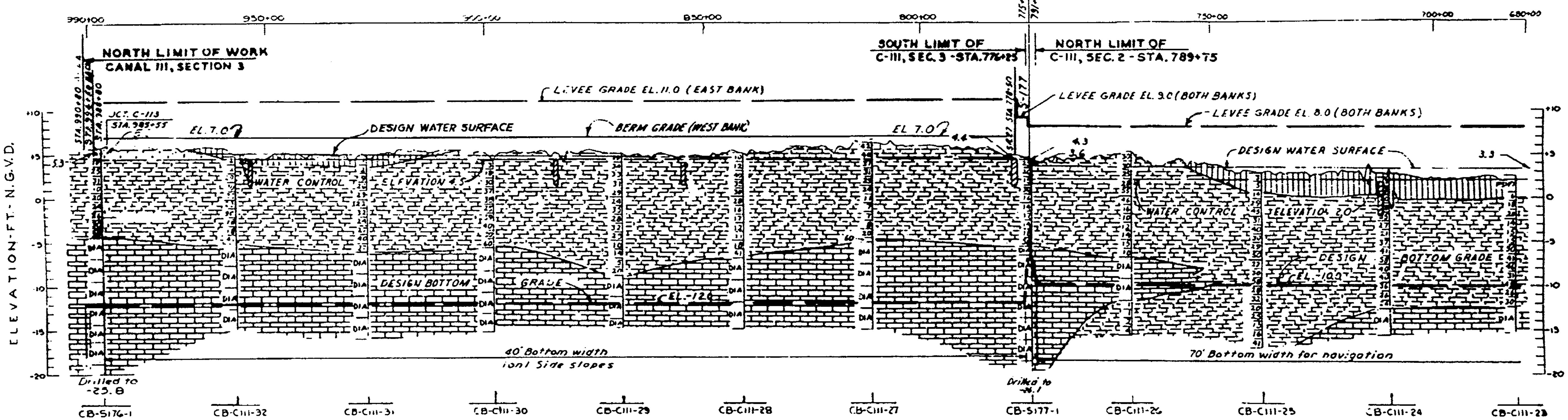
1000 0 1000 2000 3000

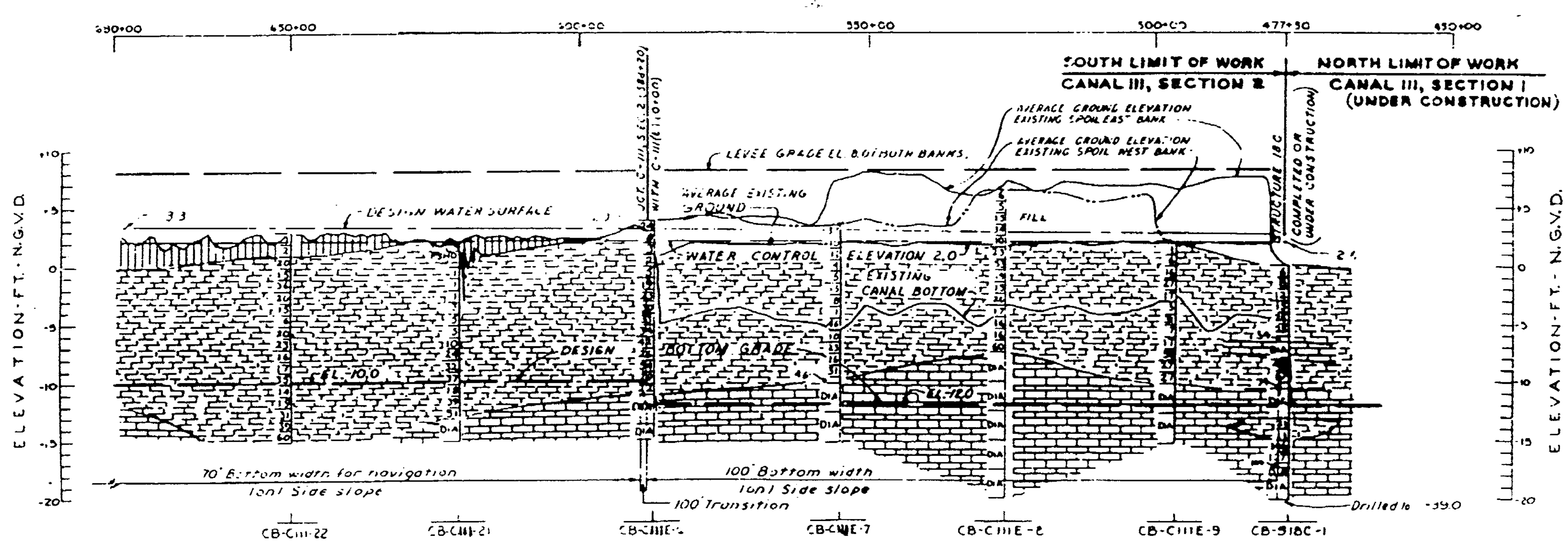
CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL 111
GENERAL REEVALUATION REPORT

LEVEE 31W
GEOLOGIC SECTION

SCALES AS SHOWN
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: DECEMBER 1993 D.O. FILE NO. 498-36,553





CORE BORING SYMBOLS AND LEGEND

SILT, CALCAREOUS (LOW PLASTICITY)(ML)

LIMESTONE, HARD, SOLUTION RIDDLED, WITH THIN SOFT LAYERS, POROUS.

LIMESTONE, MEDIUM HARD, OOLITIC, SOLUTION RIDDLED, SOLUTION HOLES PARTLY FILLED WITH SILT.

18 — NUMBER OF HAMMER BLOWS (450 FT. LBS. ENERGY) REQUIRED TO DRIVE A 2 INCH I.D. SOLID SAMPLE SPOON 1-FT. THE SPOON IS 5 FT. LONG AND DRIVEN CONTINUOUSLY 5 FT. WHERE POSSIBLE.

FELL — SPOON SUDDENLY DROPPED AS ENTERING A CAVITY.

PSHD — PUSHED SPOON DOWN WITHOUT AID OF HAMMER.

DIA — DRILLED WITH "NX" DIAMOND BIT.

NOTES:

1. MATERIAL CLASSIFIED IN ACCORDANCE WITH EM 1110-1-1806.
2. BORINGS TAKEN ALONG ℄ OF CANAL.

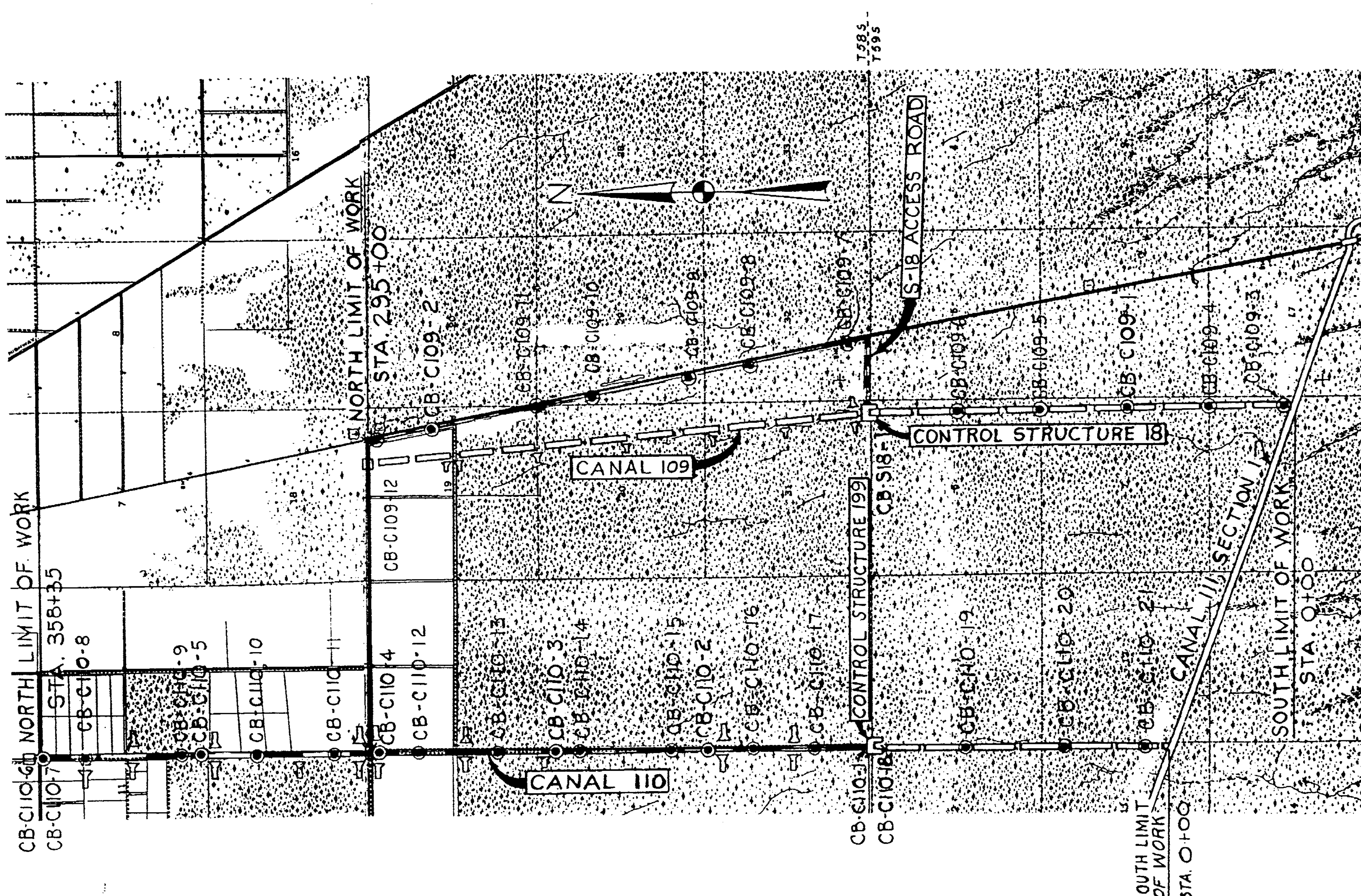
CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL III
GENERAL REEVALUATION REPORT

CANAL III AND CANAL IIIE
GEOLOGIC SECTION

SCALES AS SHOWN

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: DECEMBER 1993 D.O. FILE NO. 498-36,553



LEGEND

- PROPOSED CONTROL STRUCTURE
- PROPOSED INLET STRUCTURE
- EXISTING INLET STRUCTURE
- PROPOSED CANAL
- IMPROVED CANAL
- EXISTING CANAL
- CORE BORING LOCATION AND DESIGNATION (CB-C110-1)
- SECTION CORNER (UNRECOVERED)
- ROAD CROSSING
- BRIDGE
- ACCESS ROAD

THIS PLATE REPRODUCED FROM U.S.C. & G.S. QUAD. SHEETS:
GLADES, 1956
HOMESTEAD, 1956

SCALE IN FEET
3000 0 3000 6000

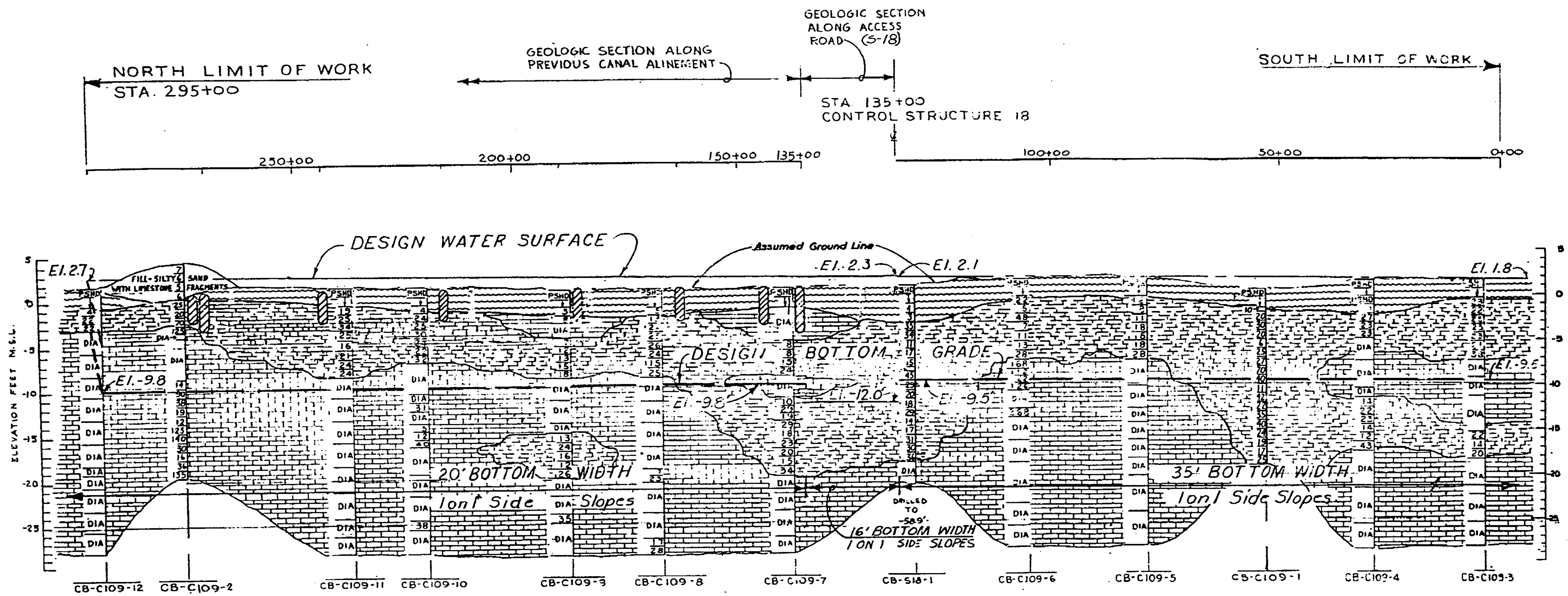
CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL 111
GENERAL REEVALUATION REPORT

CANAL 109 AND CANAL 110 CORE BORING LOCATIONS

SCALES AS SHOWN

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: DECEMBER 1993 D.O. FILE NO. 498-36,553



LEGEND

- LIMESTONE - HARD, POROUS, FOSSILIFEROUS
- LIMESTONE - MEDIUM HARD, POROUS, FOSSILIFEROUS MANY THIN HARD LAYERS
- PEAT - DARK GRAY TO DARK BROWN LAYERS AND POCKETS OF VERY SOFT CALCAREOUS SILT (PT)
- NUMBER OF HAMMER BLOWS REQUIRED TO ADVANCE A SOLID SAMPLE SPOON (2" I.D. x 2 1/2" O.D.) ONE FOOT, USING A 300 POUND HAMMER FALLING FREELY 18 INCHES. THE SPOON IS 5 FT. LONG AND IS DRIVEN CONTINUOUSLY 5 FT WHERE POSSIBLE.
- PSHD — PUSHED SPOON DOWN BY HAND
- DIA — DRILLED WITH "NX" DIAMOND BIT AND DOUBLE TUBED CORE BARREL
- PIPE DIA. — CULVERT
- CANAL SIDE INVERT

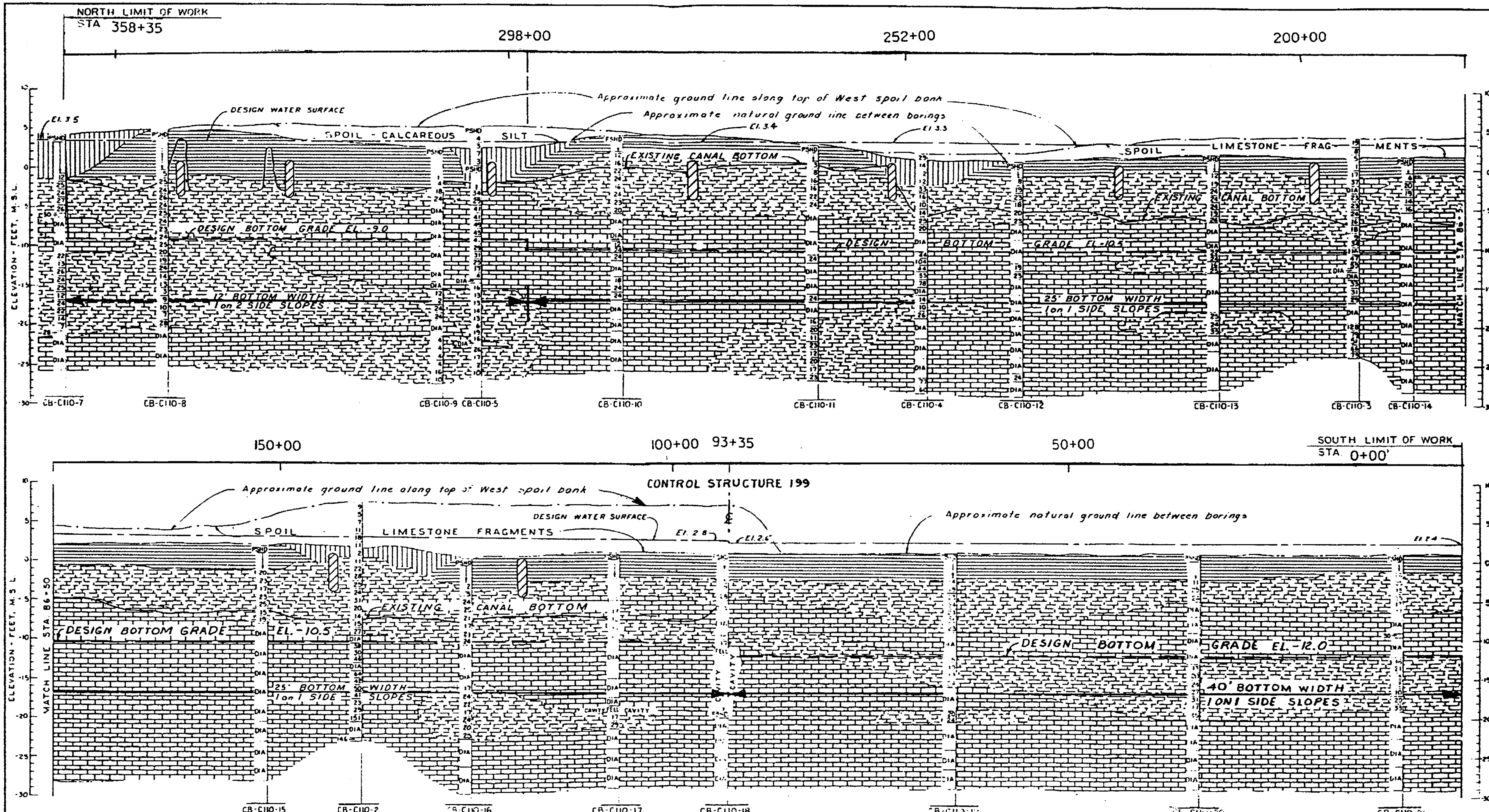
NOTE:
CORE BORING LOCATIONS SHOWN ON PLATE B-4.

CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL 111
GENERAL REEVALUATION REPORT

CANAL 109
GEOLOGIC SECTION

SCALES AS SHOWN
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: DECEMBER 1993 D.O. FILE NO. 498-36,553



LEGEND

- LIMESTONE, HARD, POROUS, FOSSILIFEROUS, SOLUTION HOLES, PERMEABLE
- LIMESTONE, MEDIUM HARD, POROUS, PERMEABLE, MANY THIN HARD LAYERS
- SILT, CALCAREOUS, VERY SOFT (ML)
- PEAT, VERY SOFT SILT POCKETS (PT)

- 24 16 24 23 20 — NUMBER OF HAMMER BLOWS REQUIRED TO ADVANCE A SOLID SAMPLE SPOON (2" I.D. x 2 1/2" O.D.) ONE FOOT, USING A 300 POUND HAMMER FALLING FREELY 18 INCHES. THE SPOON IS 5 FT. LONG AND IS DRIVEN CONTINUOUSLY 5 FT. WHERE POSSIBLE.
- DIA — DRILLED WITH "NX" DIAMOND BIT AND DOUBLE TUBED CORE BARREL
- PSHD — PUSHED SPOON DOWN BY HAND
- FELL — SPOON FELL, AS THROUGH A CAVITY
- PIPE DIA. — CULVERT — CANAL SIDE INVERT

SCALE IN FEET
1000' 0 500' 1000'

NOTE:
CORE BORING LOCATIONS SHOWN ON PLATE B-4.

CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL 111
GENERAL REEVALUATION REPORT

CANAL 110
GEOLOGIC SECTION

SCALES AS SHOWN
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: DECEMBER 1993 D.O. FILE NO. 498-36,553

C-111
GENERAL REEVALUATION REPORT
Appendix C
Real Estate Plan

Appendix C
Real Estate Plan

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Appendix C
Real Estate Plan

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Paragraph No.		Page No.

Appendix C
Real Estate Plan

TABLES

PLATES

Appendix C
Real Estate Plan

1. Statement of Purpose.

This Real Estate Plan is tentative in nature for planning purposes only and both the final real property acquisition lines and the real estate cost estimates provided may change following approval of this General Reevaluation Report (GRR). The focus of this GRR is the restoration of the ecosystem that was affected by construction of the flood control project in the C-111 basin. The study focuses providing flood protection to the agricultural land in the C-111 basin, increased water supply to the Everglades National Park and environmental restoration to the Everglades.

2. Authorization.

The initial works of the Central and Southern Florida (C&SF) Project were authorized by the Flood Control Act of 30 June 1948 (Public Law 858, 80th Congress, 2d Session). C-111 is part of the South Dade County Area Plan of Improvement which was presented in Senate Document No. 138, 87th Congress, 2d Session and subsequently authorized as an addition to the C&SF Project by the Flood Control Act of 23 October 1962 (Public Law 87-874).

In 1968, the Everglades National Park (ENP) - South Dade Conveyance Canals were authorized by Public Law 90-483, Flood Control Act of 1968. The purpose of this system was for conservation and conveyance of water supplies to the eastern portion of the ENP and to the expanding agricultural and urban areas of south Dade County. Improvements to the L-31N borrow canal enabled delivery of water to Taylor Slough (via L-31W and S-332) and the Park's eastern panhandle (via C-111) to meet minimum water deliveries to ENP mandated by Public Law 91-282. No improvements were required in C-111 to handle the increased water supply.

3. Project Location.

The Canal 111 (C-111) Basin is part of the comprehensive Central and Southern Florida (C&SF) Flood Control Project. The study area is located in the extreme southeast of Dade County, Florida, approximately 40 miles southwest of downtown Miami, and four miles west of Homestead. Dade County is Florida's most populous county and the state's third largest in land area. Dade County is bordered on the north by Broward County, to the west by Collier County and to the south by Monroe County, which contains the Florida Keys. Eastern Dade County is bordered by the Atlantic Ocean. Along the western border of Dade County is the Florida Everglades and the Everglades National Park.

The project area is generally known as the East Everglades and is a large expanse of land in extreme southeast Dade County that is approximately 32 miles long, located east of Everglades National Park and west of Homestead. The boundaries of the area form an irregular shape, but are generally C-111 and L-31N to the east, the Everglades National Park to the west, Tamiami Trail to the north and C-111 to the south extending to U.S. 1. Primary arteries providing access to the area are Krome Avenue (U.S. 27) to the east, U.S. 1 to the south and east and S.R. 9336 leading from Homestead and Florida City into the Everglades National Park. Land elevations in the East Everglades vary from 8.5 feet above mean sea level east of C-111 to one foot in the area's southwest corner adjacent to the Park boundary.

4. Project Description.

There are several alternative project plans; however, Plan 6A is the recommended plan. The objective of Plan 6A is to deliver more water to the area north of Taylor Slough and the adjacent Rocky Glades area west of L-31N. To provide for higher stages and longer hydroperiods in the marshes, a "buffer zone" would be created to protect the developed areas east of L-31N. The zone would extend from the 8.5 square mile residential area north of SW 168th Street, south to include the entire Frog Pond ownership. To create the buffer zone, two new levees (L-31W Tieback and S-332D Tieback) and borrow canal system with four pump stations (S-332A, S-332B, S-332C, and S-332D) would be constructed roughly parallel and to the west of L-31N and C-111. At the south end of the buffer zone the L-31W Tieback levee would turn eastward and tie to the C-111 levee. The cut off portion of L-31W to the west of the L31W Tieback, and the portion of L-31W south of the new borrow canal would be filled to ground level. The north end of the L-31W Tieback would tie to the south end of the seepage levee near S-357 (proposed structures just south of the 8.5 square mile area included as part of the Modified Water Deliveries to Everglades National Park Project design). S-332D Tieback will tie into high ground in the Rocky Glades area somewhat north and one-half mile west of the junction of C-102 and L-31N borrow canal. A southern segment of the levee would turn eastward and run parallel to L-31W about one-half mile west of L-31N and tie into a new pump station that would be located immediately west of S-174 (S-332D). Four pump stations and four borrow canals would draw water from Canal L-31N and the buffer area into the new canal and ultimately into Taylor Slough.

A new canal known as the Spreader Canal (C-111 North) would be constructed in the lower C-111 area to maintain flood protection capability and to supply water for environmental restoration of the area served by C-109 and C-110. The Spreader Canal would receive water from C-111E and provide conveyance east across Canals 109 and 110. Canals 109 and 110 would be plugged in several places to allow overland flow.

A large mound of material excavated in the construction of C-111 remains on the canal's south bank. Its partial gaps would be leveled to natural ground level to allow sheet flow southward. Major flood waters could be passed through the C-111 and S-197 system to Barnes Sound.

The mounds of material along C-111 and the material to be excavated from the gaps will be used to construct the new levees. If additional material is needed, the proposal is to excavate the material from the Everglades National Park adjacent to S-332B, S-332C and S-332D.

All construction work areas, access roads and disposal areas are located within the proposed right-of-way limits.

For the purpose of this planning document, all non-Federal lands identified for project purposes have been valued in fee to reflect the worst case scenario. There are approximately 11,866 acres of land required to support this project, 1,078 acres located within the Everglades National Park. Prior to acquiring any lands, a Real Estate Design Memorandum (REDM) will be prepared to determine if lesser estates can be acquired. Operational Studies will be conducted for the recommended plan during the design and construction phase to identify the optimum operating strategy for C-111 Project and the Modified Water Deliveries to ENP Project.

Because operational studies have not been completed, no determination can positively be made at the present time as to the exact number of acres required for the proposed plan nor can the estates be determined. For the lands underlying the proposed new structures (four new pump stations, the four new getaway canals, the new levees, [S-332D Tieback levee and L-31W Tieback levee], and the connector canal from C-111 to S-332) would probably have to be acquired in fee because there would be "no functional use of the land after imposition of the easement" or more than likely any easement acquired would be valued "in excess of 75 percent of fee value". (ER 405-1-2, Draft Chapter 12, paragraph 12-18b.) As to the lands within the retention/detention area in the Rocky Glades between the proposed L-31W Tieback levee and the proposed S-332D Tieback levee, the estate which would be acquired would depend on the finalization of the operating studies. It may be possible that only a permanent flowage easement would be required. The impact of the proposed plan on the remaining lands also can not as yet be determined. Upon completion of operational studies and the Feature Design Memorandum, a final determination will be made as to the exact acreage to be acquired and the estates required.

5. Government Owned Lands.

Approximately 1,078 acres of the Everglades National Park is proposed for the project. The Park boundary meanders through the western portion of the buffer zone throughout the Rocky Glades area. Everglades National Park land is included in total project acreage but has not been valued.

6. Sponsor Owned Lands.

Approximately 300 acres of the proposed project area are owned in fee by South Florida Water Management District (SFWMD). The majority of this land is in the southern portion of the proposed project.

The Department of Interior (DOI) legislation to amend the Everglades National Park Protection and Expansion Act of 1989 (P.L. 101-299), authorized the funding to acquire and cost share the lands in the Rocky Glades and Frog Pond through a 25 percent Federal (DOI) contribution. There is a strong possibility that the lands needed to support the C-111 Project will be sponsor owned prior to lands being requested for the project.

7. Appraisal Information.

The following information is extracted from the gross appraisal and the revised gross appraisal prepared for this project.

a. General. The project real estate requirements include two land classifications. From the 8.5 square mile area on the projects extreme north end, south to the southern limits of the Frog Pond, land use is agricultural. Features in this northern portion of the project include the New Canal, three cross canals for conveyance between the New Canal and L-31N, and several flood control structures. The area between the New Canal and L-31N is known as the "buffer zone". It extends from the 8.5 square mile area south to include the Frog Pond. The project's southernmost features include construction of the Spreader Canal, the plugging of C-109 and C-110 to improve overland conveyance, and the creation of gaps along the south bank of lower C-111. The land classification throughout this area is designated wetlands.

Affected agricultural land extends from SW 168th Street (the southern limit of the 8.5 Square Mile Area) to the southern portion of the Frog Pond. The area north of the Frog Pond to SW 168th Street is known as the Rocky Glades. It lies contiguous to the west of C-111/L-31N with Everglades National Park bordering the area to the west. The affected area contains approximately 290 ownerships ranging in size from 5 acres to ± 300 acres. A portion of the New Canal and buffer zone is within the Everglades National Park. The Park boundary meanders through the western portion of the buffer zone throughout the Rocky Glades area. Everglades National Park land is not included in project acreage.

Project lands in the Rocky Glades and the Frog Pond are west of C-111/L-31N. They do not receive the level of flood protection offered by the canal and are considered a riskier farming venture.

b. Rocky Glades. Project features in the Rocky Glades area north of the Frog Pond are contiguous to the buffer zone. The buffer zone in the Rocky Glades totals 5,322 acres all of which are valued in fee simple. The fee value for this area is $25,335,000. This represents the maximum interest potentially required. Exact acreage and estate will be determined in the Real Estate Design Memorandum.

c. Frog Pond. The Frog Pond ownership is ± 5,215 acres in size of which approximately 389 acres are protected tree islands and sloughs. The remainder of the Frog Pond is productive rock plowed land. The fee value for this area is $11,994,500. This represents the maximum interest potentially required. Exact acreage and estate will be determined in the Real Estate Design Memorandum.

d. Project's Southern Portion - Wetland. The project land requirements for the Spreader Canal, C-109, C-110 and the gaps along lower C-111 require a total of 251 acres of designated wetlands. The features lie predominately within one large wetland tract owned by South Florida Water Management District. Land requirements are valued in fee simple. The real estate value for this area is $251,000. This represents the maximum interest potentially required. Exact acreage and estate will be determined in the Real Estate Design Memorandum.

e. Improvements. There are four residential improvements with outbuildings and/or pole sheds located in the Rocky Glades area. Their total value is estimated by the Cost Approach to be $149,300.

f. Benefits. Benefits associated with the project are the general benefits to the farmers east of the existing L-31N, thus having no effect on this valuation. There are no special benefits associated with the project. Wetland tracts to the south are not enhanced or diminished in value by any increase in stages.

8. Severable Use Rights (SUR).

a. Background. The Metropolitan Dade County Government, as part of its zoning regulations, enacted Code Section 33B in October 1981 to protect, enhance and preserve the public and private resources of the East Everglades. These land management and development regulations are designed to provide a development alternative to on-site development of owners of land located in the East Everglades. The Code section (33B-43) creates Severable Use Rights (SURs) for these owners in statutory designated amounts. These SURs are transferrable and can be used to secure a development bonus for the development of other lands located in unincorporated Dade County.

b. Valuation of SUR. Appraisers can value SURs using the sales comparison approach if there are sufficient transactions to constitute a market. When the market is inadequate, appraisers may use the income capitalization approach. In such cases, property through the acquisition of a SUR is adjusted for administrative, legal and other costs incurred.

c. Real Property or Personal Property. For acquisition of lands by the United States Park Service within the expanded Everglades National Park and for the acquisition of the land within the eight and one half square mile area required for the Modified Water Deliveries to the ENP being acquired by the U.S. Army Corps of Engineers, the United States Department of Justice is presently in the process of determining whether SURs are real or personal property and whether the Federal government will be required to purchase the SURs. The REDM will fully address the acquisition of the SURs. For the purpose of C-111 project, any value placed on SUR if acquired would be covered in contingencies. The fee estates contained in Paragraph 23 of this report provides for acquisition of the SURs (alternative one) and for fee acquisitions which excluded the SURs (alternative two).

9. Relocation Assistance (Public Law 91-646).

There are four (4) residential improvements within the project area that may be affected by this project. If affected, the local sponsor will be required to pay relocation payments as specified under the provisions of Title II of Public Law 91-646. At this time, the estate needed in this area can not be identified. For the purpose of this planning report, estimated relocation costs are being included in total project costs.

Estimates of costs to comply with Public Law 91-646 total $90,000. This figure represents a payment of $22,500 for each of the 4 owner-occupied residential relocations which includes expenses incurred for recording fees, transfer taxes and costs of prepayment for pre-existing mortgages incident to conveying real property to the local sponsor and the estimated costs with providing displaced persons with comparable decent, safe and sanitary replacement housing.

A preliminary survey of the area indicates that there appears to be sufficient decent, safe and sanitary replacement housing available for persons affected under the project.

10. Acquisition/Administrative Costs.

Data included in calculating the project acquisition/administrative costs include an estimate of 290 ownership tracts as determined by tax maps and 4 residences requiring PL 91-646 relocations assistance.

Federal Acquisition/Administrative Cost Estimate:

Project Planning	$ 40,000
Review of Acquisitions (290 @ $500 ea)	$ 145,000
Review of Appraisals (290 @ $400 ea)	$ 116,000
Review of Condemnations (estimate of 50 @ $2,000)	$ 100,000
Review of PL 91-646 (4 @ $300)	$ 1,200
Review of Temporary Permits	$ 500
Draft PCA Review by Real Estate	$ 2,000

Total Federal Acquisition/Administrative Cost (Rounded) $ 404,700

Non-Federal Acquisition/Administrative Cost Estimate:

Acquisitions (290 @ $3,000 ea)	$ 870,000
Appraisals (290 @ $1,500 ea)	$ 435,000
Condemnations (Estimate of 50 @ $20,000 ea)	$1,000,000
PL 91-646 Assistance (4 @ $3,000 ea)	$ 12,000
Temporary Permits	$ 5,000
Damage Claims	$ 5,000

Total Non-Federal Acquisition/Administrative Cost (Rounded) $2,327,000

11. Relocations.

a. Public Highways and Bridges. One bridge crosses the floodplain of Taylor Slough, south of S-332 and physically located within Everglades National Park along State Road 9336. Increased water from the alternative requires the bridge over Taylor Slough to be expanded. State Road 9336 will be temporarily relocated to maintain traffic flow during construction of bridge openings. A temporary bypass extending 50 feet south of the existing road will be constructed adjacent to the existing road. The land needed for the bypass road is Federally owned and is not valued but has been included in the total project acreage.

b. Utilities Relocations. There are no known utilities affected by the project.

c. Relocations of Towns and Cemeteries. There are no known towns or cemeteries located within the project area.

12. Non-Federal Operation/Maintenance Responsibilities.

The operation and maintenance cost of the project are a local responsibility. However, the Flood Control Act of 1968 specified the annual pumping costs, including fuel, lubricants, proportional depreciation and repairs, and operating labor for the pump stations are cost shared 60 percent Federal and 40 percent non-Federal.

13. Local Sponsor's Authority to Participate in the Project.

The South Florida Water Management District was created by virtue of Florida Statutes, Chapter 373, Section .069. The South Florida Water Management District was created to further the State policy of flood damage prevention, preserve natural resources of the State including fish and wildlife and to assist in maintaining the navigability of rivers and harbors. (There are other enumerated purposes but they are not directly applicable to this project.) The South Florida Water Management District is specifically empowered to

> "Cooperate with the United States in the manner provided by Congress for flood control, reclamation, conservation, and allied purposes in protecting the inhabitants, the land, and other property within the district from the effects of a surplus or a deficiency of water when the same may be beneficial to the public health, welfare, safety, and utility". (Section 373.103)

To carry out the above purposes, the South Florida Water Management District is empowered to

> "...hold, control, and acquire by donation, lease, or purchase, or to condemn any land, public or private, needed for rights-of-way or other purposes, and may remove any building or other obstruction necessary for the construction, maintenance, and operation of the works; and to hold and have full control over the works and rights-of-way of the district".

The term "works of the district" is defined by Section 373.019 to be

> "those projects and works, including, but not limited to, structures, impoundments, wells, and other water courses, together with the appurtenant facilities and accompanying lands, which have been officially adopted by the governing board of the district as works of the district".

Section 373.139 specifically empowers the South Florida Water Management District

> "...to acquire fee title to real property and easements therein by purchase, gift, devise, lease, eminent domain, or otherwise for flood control, water storage, water management, and preservation of wetlands, streams and lakes, except that eminent domain powers which may be used only for acquiring real

property for flood control and water storage".

The eminent domain power is potentially limited to the above cited purposes and a resort to Federal acquisition might be required if it is construed that South Florida Water Management District's power is limited to the above cited purposes (flood control, water storage or district works). The question essentially becomes whether the governing board's adoption of the project as a district works allows use of its eminent domain powers under Section 373.086 or whether the project is for flood control and/or water storage purposes.

14. Hazardous and Toxic Wastes (HTW).

In accordance with ER 1165-2-132, an initial HTRW assessment appropriate for this study has been completed. No HTRW sites were identified on project lands.

15. Attitude of Owners.

Based on information from Jacksonville District Planning Division, the majority of the landowners do not support the project and are not willing sellers.

16. Recreation Resources.

There are no known separable recreation lands included within project lands.

17. Outstanding Rights.

Known outstanding rights include easements for roads, power lines and communication cables.

18. Minerals.

Based on South Florida Water Management District's experience to date, there is a minimal amount of outstanding mineral rights in the project area.

19. Standing Timber and Vegetative Cover.

Proposed acquisition of lands for project implementation will not consist of any area which will include standing timber or other vegetative cover that has significant recreation or scenic value, therefore, there will be no reservation of standing timber for the proposed acquisition. Standing timber has been determined to have no merchantable value.

20. Mitigation.

There are no mitigation requirements for this project.

21. Summary of Project Real Estate Costs.

The following is a summary of real estate costs for subject project.

Lands and Damages		
Lands (11,866 acres total)		
Fee Simple: 10,788 acres	$37,580,000	
ENP lands: 1,078 acres		
Subtotal		$37,580,000
Improvements:		$ 149,300
Severance Damages		$ 0
Minerals		$ 0
Total Lands and Damages (Rounded)		$37,730,000
Acquisition/Administrative Costs (Rounded)		
Federal:		$ 405,000
Non-Federal:		$ 2,327,000
Public Law 91-646 Payments (Rounded)		$ 90,000
Contingencies (25%)*(Rounded)		$10,138,000
Total Estimated Project Real Estate Costs		**$50,690,000**

*A contingency of 25% is estimated to cover uncertainties associated with such elements as valuation variance, negotiation latitude, condemnation awards and interest, and refinement of boundary lines during ownership verification.

22. Real Estate Acquisition Schedule.

The following information was taken from the proposed Project Management Plan. Based on past experience with South Florida Water Management District, Real Estate Division estimates that acquisition of approximately 290 parcels will require no less than 36 months.

Project PCA execution	Mar 96
Initiate Acquisition	Mar 96
Contracts 1 and 2 (Public lands):	
Complete Acquisition/Certify Lands	Apr 96
Construction Contract Advertised	Jun 96
Contract 3:	
Complete Acquisition/Certify Lands	Oct 98
Construction Contract Advertised	Dec 98
Contract 4:	
Complete Acquisition/Certify Lands	Aug 99
Construction Contract Advertised	Oct 99

23. Estates to be Acquired.

Fee (Alternative One)

The fee simple title to (Tracts __ & __) subject, however, to existing easements for public roads and highways, public utilities, railroads, pipelines.

Language to follow description: TOGETHER WITH the Severable Use Rights (SURs) associated with the described land, which rights exist pursuant to Metropolitan Dade County Code Section 33B.

Fee (Alternative Two)

The fee simple title to (Tracts __ & __) subject, however, to existing easements for public roads and highways, public utilities, railroads, pipelines.

Language to follow description: LESS AND EXCEPT the Severable Use Rights (SURs) associated with the described land, which rights exist pursuant to Metropolitan Dade County Code Section 33B, and which rights are expressly severed from the described land and retained by the Grantor.

In accordance with the requirements of Metropolitan Dade County Code Section 33B-45(f), the following provision is included in this deed:

This instrument restricts the use of the above described land to nonresidential uses.

Temporary Borrow Area Easement

A temporary and assignable easement and right-of-way in, on, over and across (the land described in Schedule A) (Tracts Nos. ___ & ___), for a period not to exceed 3 years, beginning with date possession of the land is granted to the United States, for use by South Florida Water Management District, its representatives, agents, and contractors as a borrow area, including the right to borrow excavate and remove material, move, store and remove equipment and supplies, and erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the C-111 Flood Control Project, together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

24. Map. Real Estate Project Planning Maps are included in this appendix as plates C-1 through C-4.

C-111
GENERAL REEVALUATION REPORT
Appendix C
Real Estate Plan

TABLES

Table C-1
CHART OF ACCOUNTS

01	LANDS AND DAMAGES		
01A00	PROJECT PLANNING		40,000
01B–	ACQUISITIONS		
01B20	BY LOCAL SPONSOR (LS)		870,000
01B40	REVIEW OF LS		145,000
01C–	CONDEMNATIONS		
01C20	BY LS		1,000,000
01C40	REVIEW OF LS		100,000
01E–	APPRAISALS		
01E30	BY LS		435,000
01E50	REVIEW OF LS		116,000
01F–	PL 91-646 ASSISTANCE		
01F10	BY LS		12,000
01F40	REVIEW OF LS		1,200
01G–	TEMPORARY PERMITS/LICENSES/RIGHTS-OF-ENTRY		
01G20	BY LS		5,000
01G40	REVIEW OF LS		500
01G60	DAMAGE CLAIMS		5,000
01M00	PROJECT RELATED ADMINISTRATION (PCA REVIEW)		2,000
01R–	REAL ESTATE PAYMENTS		
01R10	LAND PAYMENTS		
01R1B	BY LS		37,730,000
01R2-	PL 91-646 ASSISTANCE PAYMENTS		
01R2B	BY LS		90,000
01RX	CONTINGENCIES	10,138,000	
	TOTAL REAL ESTATE COSTS EXCLUDING CONTINGENCIES (RD)		**$40,552,000**
	TOTAL REAL ESTATE CONTINGENCIES COST (RD)	**$10,138,000**	
	TOTAL PROJECT REAL ESTATE COST (RD)		**$50,690,000**

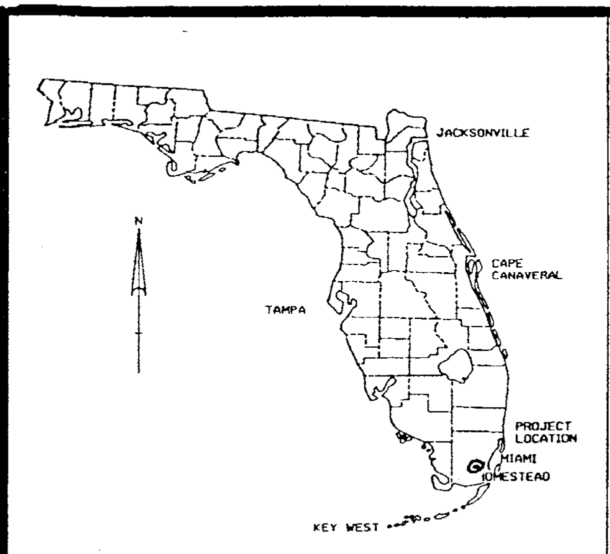
C-111
GENERAL REEVALUATION REPORT
Appendix C
Real Estate Plan

PLATES

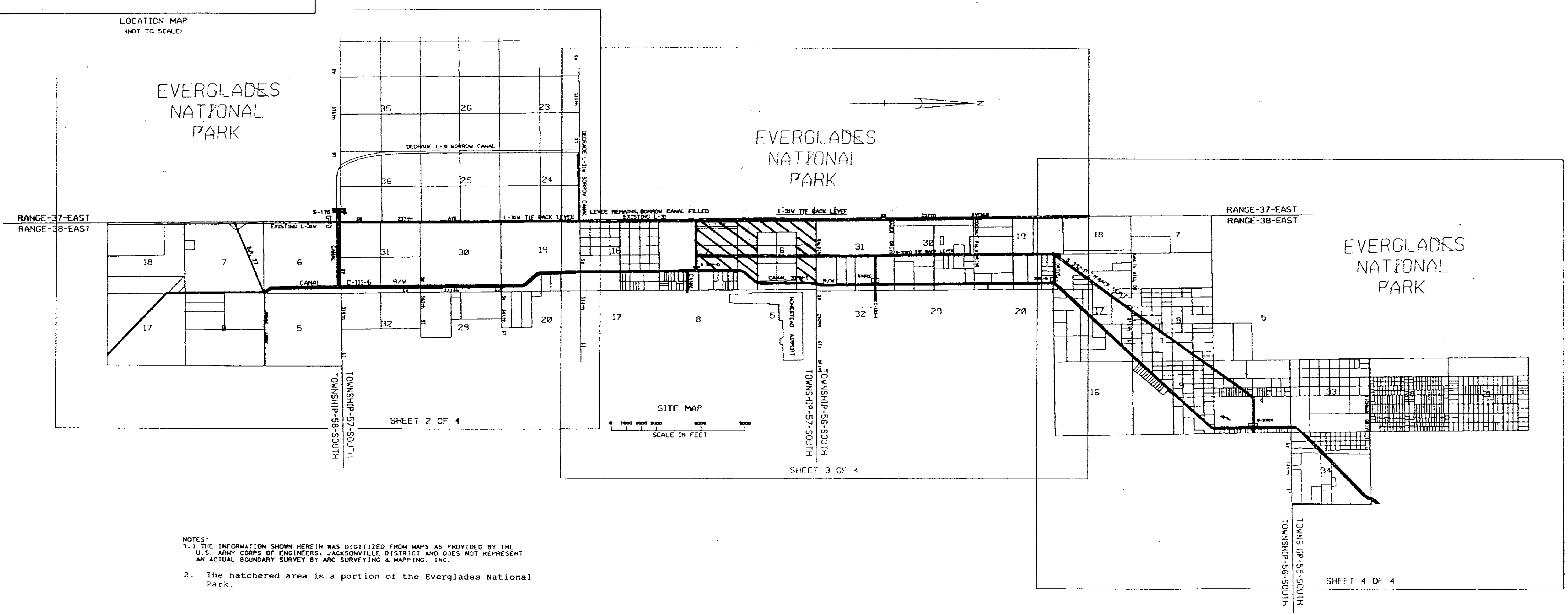
SAFTEY ON THIS JOB DEPENDS ON YOU

US Army Corps of Engineers

REVISIONS					
NO.	SYM	ZONE	DESCRIPTION	DATE	APPROVED



LOCATION MAP
(NOT TO SCALE)



NOTES:
1.) THE INFORMATION SHOWN HEREIN WAS DIGITIZED FROM MAPS AS PROVIDED BY THE U.S. ARMY CORPS OF ENGINEERS, JACKSONVILLE DISTRICT AND DOES NOT REPRESENT AN ACTUAL BOUNDARY SURVEY BY ARC SURVEYING & MAPPING, INC.

2. The hatchered area is a portion of the Everglades National Park.

PLATE C-1

ARC SURVEYING AND MAPPING, INC.
5202 SAN JUAN ANENUE, JAVKSONVILLE, FLORIDA

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

A SKETCH SHOWING PROPERTY ALONG
CANAL C-111
DADE COUNTY, FLORIDA

COVER

DWN. BY WALLEN

SCALE: AS SHOWN — DATED: 3/22/1994 — SHEET 1 OF 4

SAFETY ON THIS JOB
DEPENDS ON YOU

NO.	SYM	ZONE	REVISIONS DESCRIPTION	DATE	APPROVED

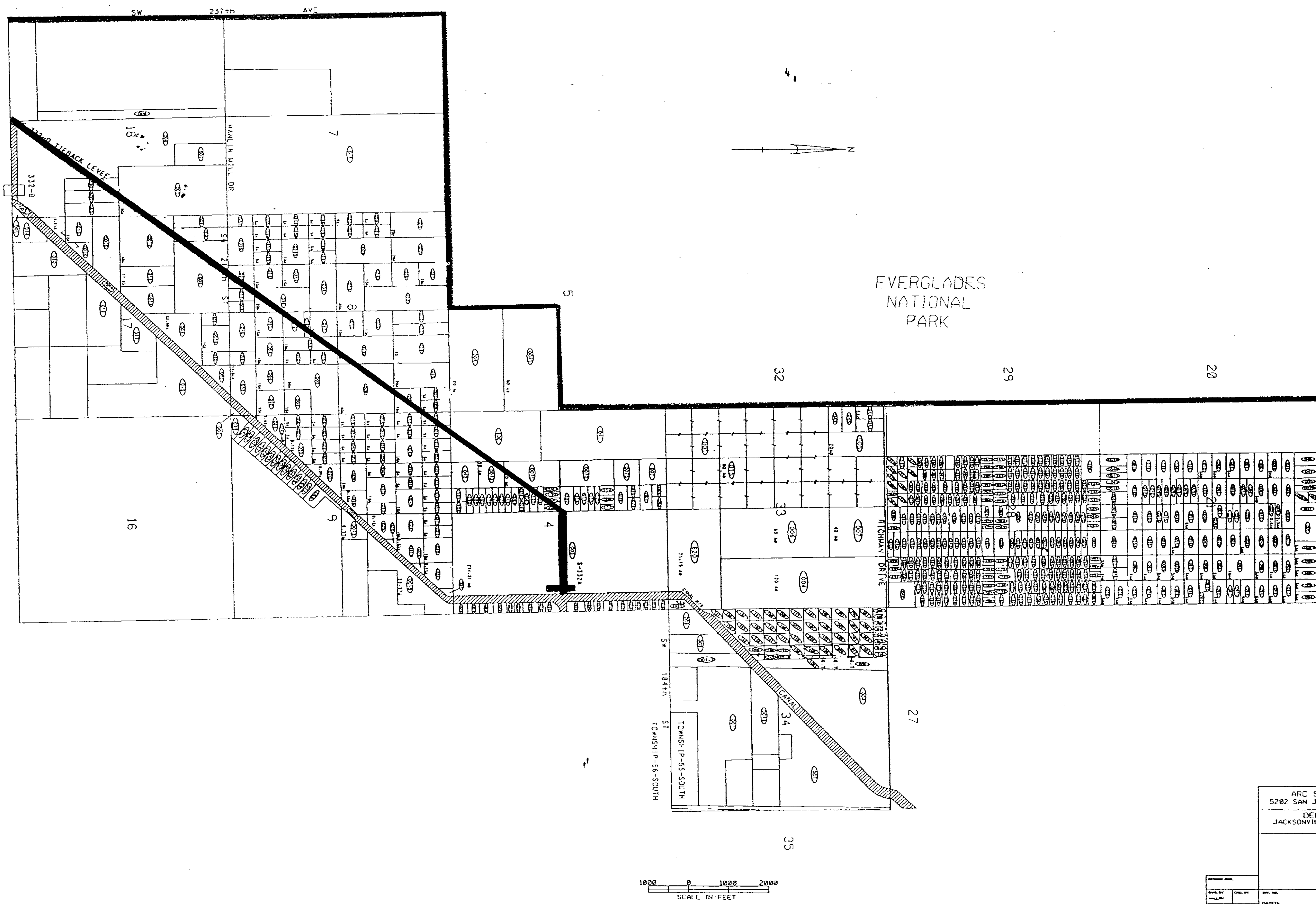


PLATE C-2

ARC SURVEYING & MAPPING, INC.
5202 SAN JUAN AVENUE, JACKSONVILLE, FLORIDA

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

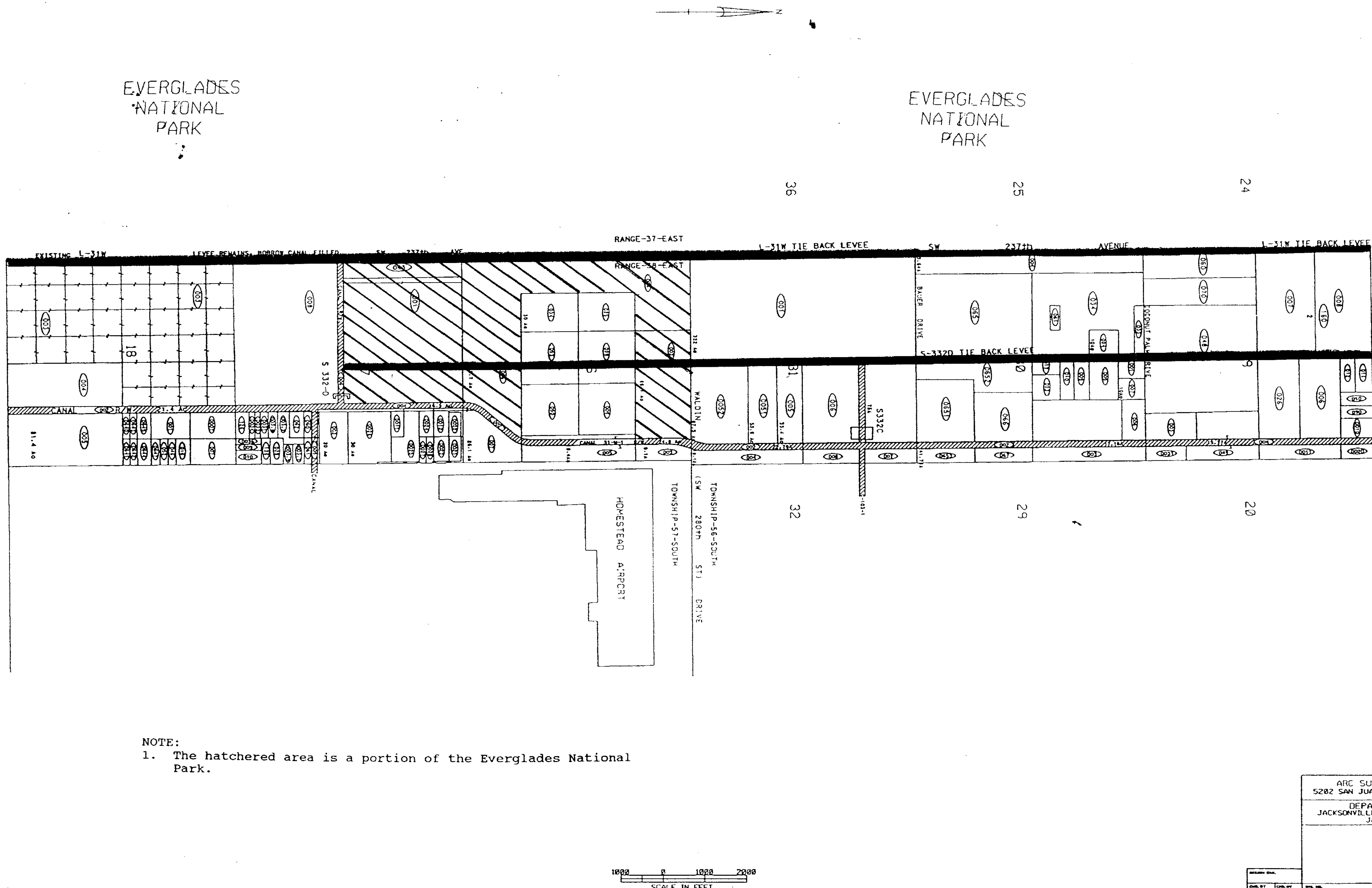
CANAL C-111

PLANNING MAP

DATED: MARCH 1994 SHEET 2 OF 4

SAFETY ON THIS JOB
DEPENDS ON YOU

REVISIONS					
NO.	SYM	ZONE	DESCRIPTION	DATE	APPROVED



NOTE:
1. The hatchered area is a portion of the Everglades National Park.

PLATE C-3

ARC SURVEYING & MAPPING, INC.
5202 SAN JUAN AVENUE, JACKSONVILLE, FLORIDA

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

CANAL C-111

PLANNING MAP

SHEET 3 OF 4

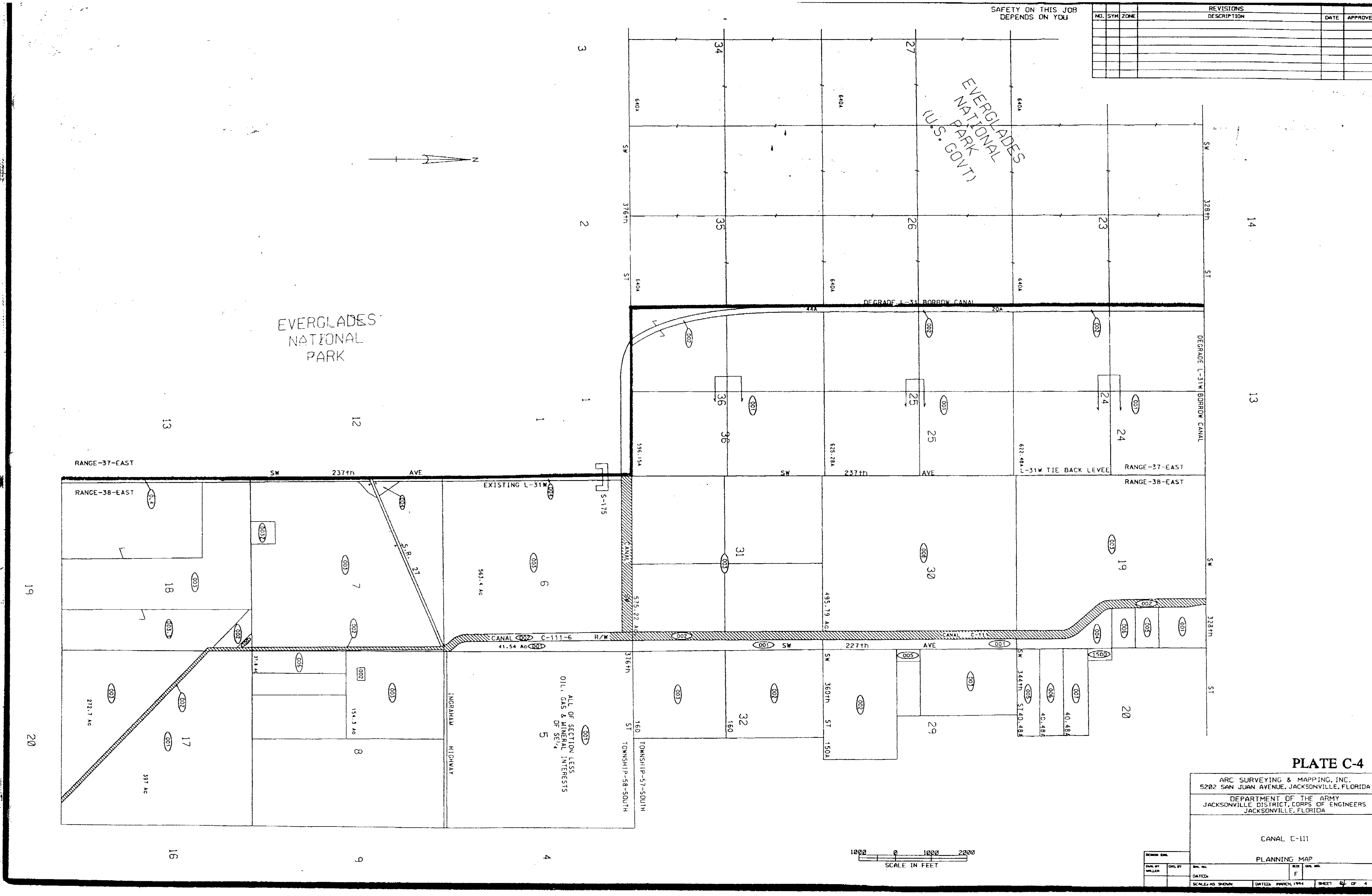

SAFETY ON THIS JOB DEPENDS ON YOU
REVISIONS
NO. SYM ZONE DESCRIPTION DATE APPROVED
EVERGLADES NATIONAL PARK (U.S. GOVT)
EVERGLADES NATIONAL PARK
DEGRADE L-31 BORROW CANAL
DEGRADE L-31W BORROW CANAL
L-31W TIE BACK LEVEE
RANGE-37-EAST
RANGE-38-EAST
SW 237th AVE
EXISTING L-31W
S-175
S.R. 27
CANAL C-111-6 R/W
CANAL C-111
SW 227th AVE
SW 376th ST
SW 360th ST
SW 344th ST
SW 328th ST
INGRAHAM HIGHWAY
ALL OF SECTION LESS OIL, GAS & MINERAL INTERESTS OF SE1/4
TOWNSHIP-58-SOUTH
TOWNSHIP-57-SOUTH
SCALE IN FEET
ARC SURVEYING & MAPPING, INC.
5202 SAN JUAN AVENUE, JACKSONVILLE, FLORIDA
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
CANAL C-111
PLANNING MAP
SCALE: AS SHOWN
DATED: MARCH, 1994

PLATE C-4

C-111
GENERAL REEVALUATION REPORT
Appendix D
Design and Cost Estimates

Appendix D
Design and Cost Estimates

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Paragraph No. | Page No.

Appendix D
Design and Cost Estimates

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Appendix D
Design and Cost Estimates

A. INTRODUCTION

1. General. This Appendix presents a discussion of applicable design considerations and construction methods utilized to establish a basis for the construction cost estimate. A discussion of the general requirements for real estate and operation and maintenance is also included.

B. DESIGN AND CONSTRUCTION

2. General. The recommended plan (Alternative 6A) would include the construction of two new north/south levees (L-31W Tieback & S-332D Tieback), four 300 cfs pumping stations, twenty-four 36-inch CMP culverts with stoplog risers, an emergency spillway across L-31W Tieback, and a new spreader canal with a 50 cfs pumping station. All pumps would be diesel operated. A detailed discussion of the recommended plan is presented in the main report.

3. Levees and Canals.

a. Levee 31W Tieback. This new north-south levee would be constructed roughly parallel to existing L-31N beginning at L-31W near S-175 and extending northward approximately 9.25 miles to higher ground in the Rocky Glades area in the vicinity of S-332B. The levee would be constructed with material obtained from the degrading of the C-111 disposal mounds along the southern portion of the project. The levee crown width would be 15 feet with 1 vertical on 3 horizontal side slopes. Twenty-four 36-inch diameter CMP culverts with stoplog risers would be placed in the levee at approximate 1000-foot intervals. An emergency spillway would also be constructed in the tieback to prevent overtopping of the levee. The spillway would be 300 feet in length and bank protection would be provided along the downstream face.

b. S-332D Tieback. This new north-south levee also would be constructed parallel to and about one-half mile west of L-31N. The southern half of the levee would tie into the new pumping station S-332D which is located just west of S-174. It would then proceed north and tie into higher ground in the Rocky Glades area a little north and one-half mile west of the junction of C-102 and L-31N borrow canal. The levee would be constructed with material obtained from the degrading of the C-111 disposal mounds with additional material obtained, as required, from excavation of a discontinuous borrow canal along the east side of the levee alinement. The levee crown width would be 15 feet with 1 vertical on 3 horizontal side slopes.

c. Levee 31W Borrow Canal. The borrow canal along the portion of the existing L-

31W between S-332 and the alinement for the new L-31W Tieback Levee would be filled by degrading the adjacent levee.

d. Discharge (Getaway) Canals at S-332A, S-332B, and S-332C. A concrete-lined discharge canal would be constructed at each structure site extending approximately one-half mile west from the structure at the L-31N borrow canal. The excavated material would be placed along both sides of the canal and graded to create a berm of sufficient elevation to satisfy the hydraulic design requirements and to provide access for maintenance.

e. Discharge (Getaway) Canal at S-332D. The existing L-31W borrow canal would be lined with concrete for a distance of approximately one-half mile west from the structure at the L-31N borrow canal. The excavated material would be placed along both sides of the canal and graded to create a berm of sufficient elevation to satisfy the hydraulic design requirements and to provide access for maintenance.

f. C-111 Connector Canal. A connector canal approximately 4500 feet in length would be constructed between C-111 and the L-31W borrow canal at S-175. The excavated material would be sidecast along one side of the canal and graded to provide access for maintenance.

g. Eastern Spreader Canal (C-111N). A canal would be constructed from the intersection of C-111 and C-111E and extend eastward to Canal 109. The excavated material would be sidecast along the north side of the canal and graded to provide access for maintenance. A canal extension between C-109 and U.S. Highway 1 is also included in the cost estimate as a separate item.

h. Canal 109 and Canal 110 Plugs. Nine plugs would be constructed in C-109 and ten plugs would be constructed in C-110 to help provide sheet flow from west to east along the C-111N alignment. Material for construction of the plugs would be obtained from the adjacent disposal mounds.

4. Pumping Stations.

a. Structural Design. At the structure sites, parking and turn-around areas would be provided on the north and south sides of the structure with a reinforced concrete service bridge spanning the structure. The proposed service bridge over the pumping station would provide access for service and fuel vehicles. An alternative access route going over the pump discharge pipes will be investigated during the preparation of the FDM. A service door at the north end of the superstructure would provide access for permitting installation and maintenance removal of the machinery and equipment. Office and toilet facilities for operating personnel would be provided at Structures 332A, 332B, 332C and 332D. The upstream wingwalls would be steel sheet pile walls capped with steel channels. In areas where the sheet piling cannot be driven due to hard rock, the bottom of the walls would be supported by tremie concrete placed in trench. Anchor walls to the steel tie rods would provide the top support for the walls. The downstream wingwalls would be reinforced concrete inverted "T" walls. A concrete apron and endsill would be provided on the downstream side of the structure. The superstructure would consist of concrete frames and concrete block curtain walls. Windows, lights, doors, and forced-air fans would be installed to provide adequate lighting and ventilation. The roof would slope to insure positive drainage. The superstructure would house the pumps, pump drive, distribution panel, station crane, office and toilet. At each pumping station flapgates would be installed at the end of each pump tube to prevent backflow through the tubes. Pump Stations S-332A, S-332B and S-332C would discharge water into concrete-lined canals extending westerly from L-31N Borrow Canal. Pump Stations S-332D would discharge water the existing L-31W borrow canal.

b. Analysis of Structures. This section includes the design criteria and describes the structural design and stability analysis required for the structures in the project. In general, the design of each structurally significant feature is described in the following text.

(1) General. The structural design is based on standard practice as set forth by the engineering and design manuals and technical letters, Corps of Engineers, U.S. Army, subject to modifications indicated by engineering judgement and experience.

(2) Design Criteria.

Reinforced Concrete. Design of structural concrete is governed by EM 1110-2-2104, "Strength Design for Reinforced Concrete Hydraulic Structures". Unless stated otherwise, the concrete compressive strength will be 3,000 psi at 28 days. Reinforcing steel would be grade 60 with a yield stress of 60,000 psi.

Structural Steel. Design of structural steel members would be governed by EM 1110-2-2101, "Working Stresses for Structural Design" and by the specifications and code of the American Institute of Steel Construction. Structural steel required for this project will be ASTM A36.

Stability Analysis. Stability analyses would be performed in accordance with ETL 1110-2-256, "Sliding Stability Analyses for Concrete Structures". Overturning analyses would be based on criteria in EM 1110-2-2502, "Retaining and Flood Walls". Flotation analyses would be performed in accordance with ETL 1110-2-307, "Floatation Stability Criteria for Concrete Hydraulic Structures".

c. Mechanical and Electrical Design - S-332A, B, C, and D.

(1) General. The proposed pump stations S-332A, B, C, and D would be located on the existing L-31N borrow canal as shown on the recommended plan plate included in Appendix A to this report. Each pump station would have a 300 cfs capacity and house four 75 cfs pumping units. These pump stations will pump water from L-31N borrow

canal into Everglades National Park. Each pump station would have four pumping bays each containing an identical axial-flow type vertical-shaft pump. Power to the pumps would be provided by diesel engines through right angle gear drives. Hydraulic design data for each pump station is provided in Appendix A to this report.

(2) Pump Design. Each of the four pumps in these pump stations shall be 36-inch pumps providing 75 cfs (33,525 gpm) at a total hydraulic head ranging from about 9 to 11 feet. The pumps shall be capable of pumping water at the maximum expected pool-to-pool elevations as follows: S-332A - 8.3 feet; S-332B - 7.3 feet; S-332C - 6.8 feet; S-332D - 6.3 feet. The pumps are expected to run at less than 500 rpm with an efficiency of about 80%. The diesel engines that power the pumps should be no larger than 150 hp. The pump station shall be designed in accordance with Hydraulic Institute Standards, EM1110-2-3105 (Mechanical/Electrical Design of Pumping Stations), and Guide Specification CW-15160 (Vertical Pumps: Axial-Flow and Mixed-Flow Impeller-Type). The design requirements for formed suction intake at the pumps shall be evaluated during preparation of the Feature Design Memorandum and shall be based upon the channel intake design.

(3) Station Equipment. The pump station will include various support items including the following:

a. Hoisting system for maintenance or repair of the pumps.
b. Diesel fuel storage system. Each pump station shall have two 12,000-gallon diesel fuel storage tanks. The 24,000-gallon total is based upon the capacity needed to operate all four pumps 24 hours a day at 8 gallons of fuel per hour per pump for 30 days.
c. Non-potable water system for general cleaning of the pump station.
d. Stilling well containing float switches to be used for pump operations.
e. Ventilation system to provide fresh air in the pump bays, generator room, office, and toilet room.
f. Toilet facility with a water closet and a lavatory.

(4) Electrical Requirements. The local power company, Florida Power and Light Company (FPL), would provide a 120/240 volt, single phase, 60 hertz, three wire, 100 amp service to each pump station. Pump stations will be equipped with small 15 KW engine-generator set for emergency power in case of failure of the commercial service. A manual transfer switch will be provided to transfer power to the emergency system.

(5) Power Distribution. A distribution panel will be provided with circuit breakers for station equipment, lighting, and controls. All wiring shall conform to guide specifications CE 1404.04 (CW 16120). Interior and exterior lighting, grounding and detail electrical design shall be in accordance with the National Electrical Code.

d. Mechanical and Electrical Design - S-332E.

(1) General. Pump station S-332E will be located at the junction of the C-111 and C-111E canals as shown on the recommended plan plate included in Appendix A. The pumping station will have a capacity of 50 cfs. It would pump water from the C-111 canal into a spreader canal (C-111N) which will spread water into the area north of the eastern panhandle of the Everglades National Park. The pump station would have one pumping bay containing an axial-flow type vertical-shaft pump. Power to the pump would be provided by a diesel engine through a right angle gear drive. The hydraulic design data for the pump station is provided in Appendix A.

(2) Pump Design. This pump station will include a single pump with a capacity of 50 cfs (22,350 gpm). The pump shall be a 30-inch pump providing the required flow at a total hydraulic head of about 6 feet. The pump shall be capable of pumping water at the maximum expected pool-to-pool elevation of 3 feet. The pump is expected to run at about 500 rpm with an efficiency of about 80%. The diesel engine that powers the pump should be no larger than 75 hp. The pump station shall be designed in accordance with Hydraulic Institute Standards, EM1110-2-3105 (Mechanical/ Electrical Design of Pumping Stations), and Guide Specification CW-15160 (Vertical Pumps: Axial-Flow and Mixed-Flow Impeller-Type). The design requirements for formed suction intake at the pump shall be evaluated during preparation of the Feature Design Memorandum and shall be based upon the channel intake design.

(3) Station Equipment. The pump station will include various support items including the following:

a. Diesel fuel storage system. The pump station shall have one 5,000-gallon diesel fuel storage tank. The 5,000-gallon total is based upon the capacity needed to operate the pump 24 hours a day at 6 gallons of fuel per hour for 30 days.
b. Stilling well containing float switches to be used for pump operations.
c. Ventilation system to provide fresh air in the pump bay and generator room.

(4) Electrical Requirement. The local power company, Florida Power and Light Company (FPL), would provide a 120/240 volt, single phase, 60 hertz, three wire, 100 amp service to the pump station. The pump station will be equipped with small 10 KW engine-generator set for emergency power in case of failure of the commercial service. A manual transfer switch will be provided to transfer power to the emergency system.

(5) Power Distribution. A distribution panel will be provided with circuit breakers for station equipment, lighting, and controls. All wiring shall conform to guide

specifications CE 1404.04 (CW 16120). Interior and exterior lighting, grounding and detail electrical design shall be in accordance with the National Electrical Code.

e. Construction Access. Access during construction and for operation and maintenance would be from State Road 9336 (Highway 27) along the existing Levee 31(W), across Structure 175, thence along the south and western side of Levee 31(W) borrow canal to Structure 332, a distance of about 2.3 miles, thence along the new Levee 31(W) Tieback to L-31N and the proposed Pumping Stations S-332A, S-332B, S-332C, and S-332D.

C. CONSTRUCTION PROCEDURE

5. General. The material removed from the western half of Canal 111, Section I between approximately station 220+00 and station 425+00 would be used to construct the new Levee 31(W) Tieback and construct the plugs in Canal 109 and Canal 110. Excess material would be placed along the north side of Canal 111 between U.S. Highway 1 and Structure 18C.

6. Construction Method. Material would be excavated by clamshell, hydraulic excavator, or similar types of equipment. Material would either be sidecast to construct a berm for access and maintenance or be truck hauled to designated for levee construction or disposal. Standard earth moving equipment would be used to construct the levees and shape the disposal mounds. Interlocking portable barges would be used to bridge Canal 111 and provide equipment access to the mounds along the south side of the canal.

D. QUANTITY AND COST ESTIMATES

7. General. The summary of the estimate for the first cost of construction of the recommended plan, including quantities, unit costs, contingencies, and reasons for contingencies is presented in Table D-1.

8. Quantity Estimates. Quantities of excavation and fill for this project were calculated based on available survey data taken from existing design memoranda and USGS Quadrangle Maps. Detailed site surveys, cross sections, and geotechnical information would be required prior to preparation of contract plans and specifications.

9. Cost Estimates. Since this project is similar to the Modified Water Deliveries Project, the cost data developed for that project was used for the Canal 111 construction cost estimate.

E. OPERATION AND MAINTENANCE

10. General. The project sponsor would be responsible for operation and maintenance of the improvements and features presented in this report upon completion of construction. The contractor would be responsible for all maintenance required during the construction

contract. Operation and maintenance of the project facilities would be performed in accordance with the instructions prepared and incorporated into the current "Operation and Maintenance Manual" which would be furnished to the project sponsor.

C-111
GENERAL REEVALUATION REPORT
Appendix D
Design and Cost Estimates

TABLES

Table D-1

GRR Estimate for C-111 - Alt 6A
South Dade Co., Florida
May 1993 Price Level

Designed By: Jacksonville District Office
Estimated By: D Cowdrey

Prepared By: M. Fascher

Date: 05/08/93

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This estimate is for C-111 GRR. The object of this project is to increase water flow to ENP. Notes under the detail items explain method and general assumptions made for this estimate. Mechanical and electrical costs were provided by Mechanical and Electrical Section and their backup for these costs is available for review.

E&D and S&I costs are based on percentages provided by Project Management. E&D is 8% and S&I is 10%.

Real Estate costs were provided by Real Estate Division.

Contingencies: With the limited design information and lack of surveys and geotechnical information, contingencies of 25% were determined to be reasonable.

SUMMARY REPORTS SUMMARY PAGE

No Detailed Estimate...

No Backup Reports...

* * * END TABLE OF CONTENTS * * *

Wed 18 May 1994 U.S. Army Corps of Engineers TIME 15:12:19

PROJECT CSF460: GRR Estimate for C-111 - Alt 6A - South Dade Co., Florida

General Reevaluation Report Estimate - C-111 SUMMARY PAGE 1

** PROJECT OWNER SUMMARY - LEVEL 1 (Rounded to 100's) **

		QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
05	3-84" CMP w/Flap Gates		645,800	161,500	807,300	
07	24 36" Culverts with Risers		3,923,200	980,800	4,904,000	
08	Structure 332A (300 cfs)		4,659,600	1,164,900	5,824,400	
09	Structure 332B (300 cfs)		4,659,600	1,164,900	5,824,400	
10	Structure 332C (300 cfs)		4,659,600	1,164,900	5,824,400	
11	Structure 332D (300 cfs)		4,659,600	1,164,900	5,824,400	
12	State Road 9336 (Bridge)		3,482,800	870,700	4,353,400	
13	Connector Canal from C-111		2,092,200	523,100	2,615,300	
14	Connector Canal @ S-332B		2,092,200	523,100	2,615,300	
15	Connector Canal @ S-332C		2,092,200	523,100	2,615,300	
16	Canal L-31W (filled in) fr S-332		3,024,100	756,000	3,780,100	
17	C-111 North		1,246,800	311,700	1,558,500	
18	Canal C-109		214,700	53,700	268,400	
19	Canal C-110		220,000	55,000	275,000	
20	Canal C-111		5,324,000	1,331,000	6,655,000	
21	Connector Canal from C-332A		2,092,200	523,100	2,615,300	
22	Existing L-31W Borrow Cl-S332D		2,010,900	502,700	2,513,600	
26	L-31W Tieback Levee		1,327,900	332,000	1,659,900	
28	Structure 332E (50 cfs)		1,043,100	260,800	1,303,900	
29	300' Spillway (Weir)		92,800	23,200	116,000	
30	S-332D Tieback Levee		615,400	153,900	769,300	
40	Lands and Damages for C-111		40,552,000	10,138,000	50,690,000	
41	Required Hydro & Bio Monitoring		6,400,000	1,600,000	8,000,000	
	GRR Estimate for C-111 - Alt 6A		97,130,500	24,282,600	121,413,200	

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LABOR ID: DADE93 EQUIP ID: RG0392 Currency in DOLLARS CREW ID: NAT92A UPB ID: NAT92A

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
05 3-84" CMP w/Flap Gates					
05- A Construction Cost		547,300	136,800	684,200	
05- B Non-Construction Cost		98,500	24,600	123,100	
3-84" CMP w/Flap Gates		645,800	161,500	807,300	
07 24 36" Culverts with Risers					
07- A Construction Cost		3,324,700	831,200	4,155,900	
07- B Non-Construction Cost		598,500	149,600	748,100	
24 36" Culverts with Risers		3,923,200	980,800	4,904,000	
08 Structure 332A (300 cfs)					
08- A Construction Cost		3,948,800	987,200	4,936,000	
08- B Non-Construction Cost		710,800	177,700	888,500	
Structure 332A (300 cfs)		4,659,600	1,164,900	5,824,400	
09 Structure 332B (300 cfs)					
09- A Construction Cost		3,948,800	987,200	4,936,000	
09- B Non-Construction Cost		710,800	177,700	888,500	
Structure 332B (300 cfs)		4,659,600	1,164,900	5,824,400	
10 Structure 332C (300 cfs)					
10- A Construction Cost		3,948,800	987,200	4,936,000	
10- B Non-Construction Cost		710,800	177,700	888,500	
Structure 332C (300 cfs)		4,659,600	1,164,900	5,824,400	
11 Structure 332D (300 cfs)					
11- A Construction Cost		3,948,800	987,200	4,936,000	
11- B Non-Construction Cost		710,800	177,700	888,500	
Structure 332D (300 cfs)		4,659,600	1,164,900	5,824,400	
12 State Road 9336 (Bridge)					
12- A Construction Costs		2,951,500	737,900	3,689,400	

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
12- B Non-Construction Cost		531,300	132,800	664,100	
State Road 9336 (Bridge)		3,482,800	870,700	4,353,400	
13 Connector Canal from C-111					
13- A Construction Cost		1,773,100	443,300	2,216,300	
13- B Non-Construction Cost		319,200	79,800	399,000	
Connector Canal from C-111		2,092,200	523,100	2,615,300	
14 Connector Canal @ S-332B					
14- A Construction Cost		1,773,100	443,300	2,216,300	
14- B Non-Construction Cost		319,200	79,800	399,000	
Connector Canal @ S-332B		2,092,200	523,100	2,615,300	
15 Connector Canal @ S-332C					
15- A Construction Cost		1,773,100	443,300	2,216,300	
15- B Non-Construction Cost		319,200	79,800	399,000	
Connector Canal @ S-332C		2,092,200	523,100	2,615,300	
16 Canal L-31W (filled in) fr S-332					
16- A Construction Cost		2,562,800	640,700	3,203,500	
16- B Non-Construction Cost		461,300	115,300	576,600	
Canal L-31W (filled in) fr S-332		3,024,100	756,000	3,780,100	
17 C-111 North					
17- A Construction Cost		1,056,600	264,100	1,320,700	
17- B Non-Construction Cost		190,200	47,500	237,700	
C-111 North		1,246,800	311,700	1,558,500	
18 Canal C-109					
18- A Construction Cost		181,900	45,500	227,400	
18- B Non-Construction Cost		32,700	8,200	40,900	
Canal C-109		214,700	53,700	268,400	

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
19 Canal C-110					
19- A Construction Cost		186,400	46,600	233,100	
19- B Non-Construction Cost		33,600	8,400	41,900	
Canal C-110		220,000	55,000	275,000	
20 Canal C-111					
20- A Construction Cost		4,511,900	1,128,000	5,639,800	
20- B Non-Construction Cost		812,100	203,000	1,015,200	
Canal C-111		5,324,000	1,331,000	6,655,000	
21 Connector Canal from C-332A					
21- A Construction Cost		1,773,100	443,300	2,216,300	
21- B Non-Construction Cost		319,200	79,800	399,000	
Connector Canal from C-332A		2,092,200	523,100	2,615,300	
22 Existing L-31W Borrow Cl-S332D					
22- A Construction Cost		1,704,100	426,000	2,130,200	
22- B Non-Construction Cost		306,700	76,700	383,400	
Existing L-31W Borrow Cl-S332D		2,010,900	502,700	2,513,600	
26 L-31W Tieback Levee					
26- A Construction Cost		1,125,400	281,300	1,406,700	
26- B Non-Construction Cost		202,600	50,600	253,200	
L-31W Tieback Levee		1,327,900	332,000	1,659,900	
28 Structure 332E (50 cfs)					
28- A Construction Cost		881,900	220,500	1,102,300	
28- B Non-Construction Cost		161,200	40,300	201,600	
Structure 332E (50 cfs)		1,043,100	260,800	1,303,900	
29 300' Spillway (Weir)					
29- A Construction Cost		78,700	19,700	98,400	

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
29- B Non-Construction Cost		14,100	3,500	17,600	
300' Spillway (Weir)		92,800	23,200	116,000	
30 S-332D Tieback Levee					
30- A Construction Cost		521,600	130,400	651,900	
30- B Non-Construction Cost		93,900	23,500	117,400	
S-332D Tieback Levee		615,400	153,900	769,300	
40 Lands and Damages for C-111					
40- B Non-Construction Cost		40,552,000	10,138,000	50,690,000	
Lands and Damages for C-111		40,552,000	10,138,000	50,690,000	
41 Required Hydro & Bio Monitoring					
41- B Non-Construction Cost		6,400,000	1,600,000	8,000,000	
Required Hydro & Bio Monitoring		6,400,000	1,600,000	8,000,000	
GRR Estimate for C-111 - Alt 6A		97,130,500	24,282,600	121,413,200	

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	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
05 3-84" CMP W/Flap Gates					
05- A Construction Cost					
05- A/15 Floodway Control-Diversion Struc					
05- A/15.00 Floodway Control-Diversion Struc					
05- A/15.00.01 Mob, Demob & Preparatory Work					
05- A/15.00.01/01 Mob, Demob & Preparatory Work		21,100	5,300	26,400	
Mob, Demob & Preparatory Work		21,100	5,300	26,400	
05- A/15.00.03 Care and Diversion of Water					
05- A/15.00.03/01 Dewatering		27,500	6,900	34,300	
Care and Diversion of Water		27,500	6,900	34,300	
05- A/15.00.10 Earthwork for Structures					
05- A/15.00.10/01 Excavation	7000.00 CY	50,500	12,600	63,100	9.01
05- A/15.00.10/02 Fill and Backfill	10000.00 CY	71,900	18,000	89,900	8.99
05- A/15.00.10/03 Riprap Stone	400.00 CY	22,600	5,600	28,200	70.61
05- A/15.00.10/04 Bedding Stone	600.00 CY	27,500	6,900	34,400	57.31
05- A/15.00.10/05 84" DIA CMP	300.00 LF	61,900	15,500	77,400	257.89
05- A/15.00.10/06 Select Fill	2000.00 CY	183,400	45,800	229,200	114.62
Earthwork for Structures		417,800	104,400	522,200	
05- A/15.00.11 Foundation Work					
05- A/15.00.11/01 Timber Piling	100.00 LF	2,600	600	3,200	31.94
05- A/15.00.11/03 Staff Gages		3,800	1,000	4,800	
Foundation Work		6,400	1,600	8,000	
05- A/15.00.99 Associated General Items					
05- A/15.00.99/03 Clearing and Grubbing	4.00 ACR	4,500	1,100	5,600	1405.56
05- A/15.00.99/04 Sodding	1800.00 SY	6,300	1,600	7,900	4.40
05- A/15.00.99/10 Mech - 84" Flap Gates	3.00 EA	62,500	15,600	78,200	26061.19
05- A/15.00.99/11 Mech - Misc Metal		1,300	300	1,600	
Associated General Items		74,600	18,700	93,300	

	QUANTITY	UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
Floodway Control-Diversion Struc			547,300	136,800	684,200	
Floodway Control-Diversion Struc			547,300	136,800	684,200	
Construction Cost			547,300	136,800	684,200	
05- B Non-Construction Cost						
05- B/30 Planning, Engineering and Design						
Planning, Engineering and Design			43,800	11,000	54,800	
05- B/31 Construction Management (S&I)						
Construction Management (S&I)			54,700	13,700	68,400	
Non-Construction Cost			98,500	24,600	123,100	
3-84" CMP w/Flap Gates			645,800	161,500	807,300	
07 24 36" Culverts with Risers						
07- A Construction Cost						
07- A/15 Floodway Control-Diversion Struc						
07- A/15.00 Floodway Control-Diversion Struc						
07- A/15.00.01 Mob, Demob & Preparatory Work						
07- A/15.00.01/01 Mob, Demob & Preparatory Work			148,700	37,200	185,800	
Mob, Demob & Preparatory Work			148,700	37,200	185,800	
07- A/15.00.03 Care and Diversion of Water						
07- A/15.00.03/01 Dewatering			362,400	90,600	453,000	
Care and Diversion of Water			362,400	90,600	453,000	
07- A/15.00.10 Earthwork for Structures						
07- A/15.00.10/01 Excavation	60000.00	CY	434,200	108,500	542,700	9.05
07- A/15.00.10/02 Fill and Backfill	36000.00	CY	234,100	58,500	292,600	8.13
07- A/15.00.10/03 Riprap Stone	7200.00	CY	406,700	101,700	508,400	70.61

		QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
07- A/15.00.10/04	Bedding Stone	10800.00 CY	495,200	123,800	619,000	57.31
07- A/15.00.10/05	36" DIA CMP	1800.00 LF	95,800	24,000	119,800	66.55
07- A/15.00.10/06	Select Fill	7200.00 CY	330,100	82,500	412,600	57.31
	Earthwork for Structures		1,996,100	499,000	2,495,100	
07- A/15.00.11	Foundation Work					
07- A/15.00.11/01	Timber Piling	5280.00 LF	134,900	33,700	168,600	31.94
07- A/15.00.11/02	Timber Walkway & Platform	24.00 EA	306,600	76,700	383,300	15970.63
07- A/15.00.11/03	Staff Gages	24.00 EA	92,000	23,000	115,000	4791.19
	Foundation Work		533,500	133,400	666,900	
07- A/15.00.99	Associated General Items					
07- A/15.00.99/03	Clearing and Grubbing	12.00 ACR	27,000	6,700	33,700	2811.12
07- A/15.00.99/04	Sodding	12000.00 SY	42,300	10,600	52,800	4.40
07- A/15.00.99/10	36" Weir Culvert Risers	24.00 EA	201,200	50,300	251,500	10480.61
07- A/15.00.99/11	Mech - Misc Metal		13,600	3,400	17,000	
	Associated General Items		284,100	71,000	355,100	
	Floodway Control-Diversion Struc		3,324,700	831,200	4,155,900	
	Floodway Control-Diversion Struc		3,324,700	831,200	4,155,900	
	Construction Cost		3,324,700	831,200	4,155,900	
07- B	Non-Construction Cost					
07- B/30	Planning, Engineering and Design					
	Planning, Engineering and Design		266,000	66,500	332,500	
07- B/31	Construction Management (S&I)					
	Construction Management (S&I)		332,500	83,100	415,600	
	Non-Construction Cost		598,500	149,600	748,100	
	24 36" Culverts with Risers		3,923,200	980,800	4,904,000	
08	Structure 332A (300 cfs)					
08- A	Construction Cost					

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
08- A/09 Channels and Canals					
08- A/09.02 Canals					
08- A/09.02.01 Mob, Demob & Preparatory Work					
08- A/09.02.01/ 1 Mob, Demob & Preparatory Work		2,600	600	3,200	
Mob, Demob & Preparatory Work		2,600	600	3,200	
08- A/09.02.99 Associated General Items					
08- A/09.02.99/ 2 Clearing	1.00 ACR	2,200	600	2,800	2811.12
08- A/09.02.99/01 Excavation	2500.00 CY	10,100	2,500	12,700	5.07
Associated General Items		12,400	3,100	15,500	
Canals		14,900	3,700	18,700	
Channels and Canals		14,900	3,700	18,700	
08- A/11 Levees and Floodwalls					
08- A/11.01 Levees					
08- A/11.01.01 Mob, Demob & Preparatory Work					
08- A/11.01.01/ 1 Mob, Demob & Preparatory Work		2,600	600	3,200	
Mob, Demob & Preparatory Work		2,600	600	3,200	
08- A/11.01.99 Associated General Items					
08- A/11.01.99/01 Embankment Fill	7500.00 CCY	18,600	4,600	23,200	3.10
08- A/11.01.99/02 Grassing	1.00 ACR	1,800	500	2,300	2263.74
Associated General Items		20,400	5,100	25,500	
Levees		23,000	5,700	28,700	
Levees and Floodwalls		23,000	5,700	28,700	
08- A/13 Pumping Plant					
08- A/13.00 Pumping Plant					

		QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
08- A/13.00.01	Mob, Demob & Preparatory Work					
08- A/13.00.01/ 1	Mob, Demob & Preparatory Work		162,300	40,600	202,800	
	Mob, Demob & Preparatory Work		162,300	40,600	202,800	
08- A/13.00.03	Care and Diversion of Water					
08- A/13.00.03/01	Dewatering		219,600	54,900	274,500	
	Care and Diversion of Water		219,600	54,900	274,500	
08- A/13.00.10	Earthwork for Structures					
08- A/13.00.10/01	Excavation	8000.00 CY	81,900	20,500	102,400	12.80
08- A/13.00.10/02	Fill and Backfill	7000.00 CY	81,900	20,500	102,300	14.62
08- A/13.00.10/03	Stone Protection	350.00 CY	19,800	4,900	24,700	70.61
08- A/13.00.10/04	Discharge Sumi Excavation	3000.00 CY	12,200	3,000	15,200	5.07
	Earthwork for Structures		195,700	48,900	244,600	
08- A/13.00.11	Foundation Work					
08- A/13.00.11/01	Steel Sheetpiling	2500.00 SF	70,300	17,600	87,900	35.14
	Foundation Work		70,300	17,600	87,900	
08- A/13.00.74	Pumping Plant Substructure					
08- A/13.00.74/01	Concrete - In place	3000.00 CY	1,410,600	352,600	1,763,200	587.74
08- A/13.00.74/03	Reinforcing Steel	250000.00 LBS	300,500	75,100	375,600	1.50
08- A/13.00.74/04	Misc Struct Steel	8000.00 LBS	8,400	2,100	10,500	1.31
	Pumping Plant Substructure		1,719,500	429,900	2,149,300	
08- A/13.00.75	Pumping Plant Superstructure					
08- A/13.00.75/ 1	Superstructure		99,800	25,000	124,800	
	Pumping Plant Superstructure		99,800	25,000	124,800	
08- A/13.00.76	Pumping Machinery and Appurtenan					
08- A/13.00.76/01	Mechanical		440,800	110,200	551,000	
08- A/13.00.76/02	Station Cost		209,500	52,400	261,900	

		QUANTITY	UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
08- A/13.00.76/03	Electrical			199,600	49,900	249,500	
08- A/13.00.76/04	Fuel Systems			239,600	59,900	299,400	
08- A/13.00.76/06	Formed Suction Intake			199,600	49,900	249,500	
	Pumping Machinery and Appurtenan			1,289,100	322,300	1,611,400	
08- A/13.00.99	Associated General Items						
08- A/13.00.99/ 1	Metals - Grating	800.00	SF	17,600	4,400	22,000	27.47
08- A/13.00.99/ 2	Metals - Handrail	400.00	LF	10,400	2,600	13,000	32.44
08- A/13.00.99/ 3	Gurardrail	300.00	LF	6,600	1,600	8,200	27.47
08- A/13.00.99/ 4	Staff Gages (2)			3,000	700	3,700	
08- A/13.00.99/ 5	Pavement	1500.00	SY	42,200	10,500	52,700	35.14
08- A/13.00.99/ 6	Emergency Steel Bulkhead			59,900	15,000	74,900	
08- A/13.00.99/ 7	Pickup Beam			5,000	1,200	6,200	
08- A/13.00.99/ 8	Access Road			10,000	2,500	12,500	
	Associated General Items			154,600	38,600	193,200	
	Pumping Plant			3,910,900	977,700	4,888,600	
	Pumping Plant			3,910,900	977,700	4,888,600	
	Construction Cost			3,948,800	987,200	4,936,000	
08- B	Non-Construction Cost						
08- B/30	Planning, Engineering and Design						
	Planning, Engineering and Design			315,900	79,000	394,900	
08- B/31	Construction Management (S&I)						
	Construction Management (S&I)			394,900	98,700	493,600	
	Non-Construction Cost			710,800	177,700	888,500	
	Structure 332A (300 cfs)			4,659,600	1,164,900	5,824,400	
09	Structure 332B (300 cfs)						
09- A	Construction Cost						
09- A/09	Channels and Canals						
09- A/09.02	Canals						

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
09- A/09.02.01 Mob, Demob & Preparatory Work					
09- A/09.02.01/ 1 Mob, Demob & Preparatory Work		2,600	600	3,200	
Mob, Demob & Preparatory Work		2,600	600	3,200	
09- A/09.02.99 Associated General Items					
09- A/09.02.99/ 2 Clearing	1.00 ACR	2,200	600	2,800	2811.12
09- A/09.02.99/01 Excavation	2500.00 CY	10,100	2,500	12,700	5.07
Associated General Items		12,400	3,100	15,500	
Canals		14,900	3,700	18,700	
Channels and Canals		14,900	3,700	18,700	
09- A/11 Levees and Floodwalls					
09- A/11.01 Levees					
09- A/11.01.01 Mob, Demob & Preparatory Work					
09- A/11.01.01/ 1 Mob, Demob & Preparatory Work		2,600	600	3,200	
Mob, Demob & Preparatory Work		2,600	600	3,200	
09- A/11.01.99 Associated General Items					
09- A/11.01.99/01 Embankment Fill	7500.00 CCY	18,600	4,600	23,200	3.10
09- A/11.01.99/02 Grassing	1.00 ACR	1,800	500	2,300	2263.74
Associated General Items		20,400	5,100	25,500	
Levees		23,000	5,700	28,700	
Levees and Floodwalls		23,000	5,700	28,700	
09- A/13 Pumping Plant					
09- A/13.00 Pumping Plant					
09- A/13.00.01 Mob, Demob & Preparatory Work					
09- A/13.00.01/ 1 Mob, Demob & Preparatory Work		162,300	40,600	202,800	
Mob, Demob & Preparatory Work		162,300	40,600	202,800	

		QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
09- A/13.00.03	Care and Diversion of Water					
09- A/13.00.03/01	Dewatering		219,600	54,900	274,500	
	Care and Diversion of Water		219,600	54,900	274,500	
09- A/13.00.10	Earthwork for Structures					
09- A/13.00.10/01	Excavation	8000.00 CY	81,900	20,500	102,400	12.80
09- A/13.00.10/02	Fill and Backfill	7000.00 CY	81,900	20,500	102,300	14.62
09- A/13.00.10/03	Stone Protection	350.00 CY	19,800	4,900	24,700	70.61
09- A/13.00.10/04	Discharge Sumi Excavation	3000.00 CY	12,200	3,000	15,200	5.07
	Earthwork for Structures		195,700	48,900	244,600	
09- A/13.00.11	Foundation Work					
09- A/13.00.11/01	Steel Sheetpiling	2500.00 SF	70,300	17,600	87,900	35.14
	Foundation Work		70,300	17,600	87,900	
09- A/13.00.74	Pumping Plant Substructure					
09- A/13.00.74/01	Concrete - In place	3000.00 CY	1,410,600	352,600	1,763,200	587.74
09- A/13.00.74/03	Reinforcing Steel	250000.00 LBS	300,500	75,100	375,600	1.50
09- A/13.00.74/04	Misc Struct Steel	8000.00 LBS	8,400	2,100	10,500	1.31
	Pumping Plant Substructure		1,719,500	429,900	2,149,300	
09- A/13.00.75	Pumping Plant Superstructure					
09- A/13.00.75/ 1	Superstructure		99,800	25,000	124,800	
	Pumping Plant Superstructure		99,800	25,000	124,800	
09- A/13.00.76	Pumping Machinery and Appurtenan					
09- A/13.00.76/01	Mechanical		440,800	110,200	551,000	
09- A/13.00.76/02	Station Cost		209,500	52,400	261,900	
09- A/13.00.76/03	Electrical		199,600	49,900	249,500	
09- A/13.00.76/04	Fuel Systems		239,600	59,900	299,400	
09- A/13.00.76/06	Formed Suction Intake		199,600	49,900	249,500	
	Pumping Machinery and Appurtenan		1,289,100	322,300	1,611,400	

		QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
09- A/13.00.99	Associated General Items					
09- A/13.00.99/ 1	Metals - Grating	800.00 SF	17,600	4,400	22,000	27.47
09- A/13.00.99/ 2	Metals - Handrail	400.00 LF	10,400	2,600	13,000	32.44
09- A/13.00.99/ 3	Gurardrail	300.00 LF	6,600	1,600	8,200	27.47
09- A/13.00.99/ 4	Staff Gages (2)		3,000	700	3,700	
09- A/13.00.99/ 5	Pavement	1500.00 SY	42,200	10,500	52,700	35.14
09- A/13.00.99/ 6	Emergency Steel Bulkhead		59,900	15,000	74,900	
09- A/13.00.99/ 7	Pickup Beam		5,000	1,200	6,200	
09- A/13.00.99/ 8	Access Road		10,000	2,500	12,500	
	Associated General Items		154,600	38,600	193,200	
	Pumping Plant		3,910,900	977,700	4,888,600	
	Pumping Plant		3,910,900	977,700	4,888,600	
	Construction Cost		3,948,800	987,200	4,936,000	
09- B	Non-Construction Cost					
09- B/30	Planning, Engineering and Design					
	Planning, Engineering and Design		315,900	79,000	394,900	
09- B/31	Construction Management (S&I)					
	Construction Management (S&I)		394,900	98,700	493,600	
	Non-Construction Cost		710,800	177,700	888,500	
	Structure 332B (300 cfs)		4,659,600	1,164,900	5,824,400	
10	Structure 332C (300 cfs)					
10- A	Construction Cost					
10- A/09	Channels and Canals					
10- A/09.02	Canals					
10- A/09.02.01	Mob, Demob & Preparatory Work					
10- A/09.02.01/ 1	Mob, Demob & Preparatory Work		2,600	600	3,200	
	Mob, Demob & Preparatory Work		2,600	600	3,200	

		QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
10- A/09.02.99 Associated General Items						
10- A/09.02.99/ 2	Clearing	1.00 ACR	2,200	600	2,800	2811.12
10- A/09.02.99/01	Excavation	2500.00 CY	10,100	2,500	12,700	5.07
	Associated General Items		12,400	3,100	15,500	
	Canals		14,900	3,700	18,700	
	Channels and Canals		14,900	3,700	18,700	
10- A/11 Levees and Floodwalls						
10- A/11.01 Levees						
10- A/11.01.01 Mob, Demob & Preparatory Work						
10- A/11.01.01/ 1	Mob, Demob & Preparatory Work		2,600	600	3,200	
	Mob, Demob & Preparatory Work		2,600	600	3,200	
10- A/11.01.99 Associated General Items						
10- A/11.01.99/01	Embankment Fill	7500.00 CCY	18,600	4,600	23,200	3.10
10- A/11.01.99/02	Grassing	1.00 ACR	1,800	500	2,300	2263.74
	Associated General Items		20,400	5,100	25,500	
	Levees		23,000	5,700	28,700	
	Levees and Floodwalls		23,000	5,700	28,700	
10- A/13 Pumping Plant						
10- A/13.00 Pumping Plant						
10- A/13.00.01 Mob, Demob & Preparatory Work						
10- A/13.00.01/ 1	Mob, Demob & Preparatory Work		162,300	40,600	202,800	
	Mob, Demob & Preparatory Work		162,300	40,600	202,800	
10- A/13.00.03 Care and Diversion of Water						
10- A/13.00.03/01	Dewatering		219,600	54,900	274,500	
	Care and Diversion of Water		219,600	54,900	274,500	

		QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
10- A/13.00.10	Earthwork for Structures					
10- A/13.00.10/01	Excavation	8000.00 CY	81,900	20,500	102,400	12.80
10- A/13.00.10/02	Fill and Backfill	7000.00 CY	81,900	20,500	102,300	14.62
10- A/13.00.10/03	Stone Protection	350.00 CY	19,800	4,900	24,700	70.61
10- A/13.00.10/04	Discharge Sumi Excavation	3000.00 CY	12,200	3,000	15,200	5.07
	Earthwork for Structures		195,700	48,900	244,600	
10- A/13.00.11	Foundation Work					
10- A/13.00.11/01	Steel Sheetpiling	2500.00 SF	70,300	17,600	87,900	35.14
	Foundation Work		70,300	17,600	87,900	
10- A/13.00.74	Pumping Plant Substructure					
10- A/13.00.74/01	Concrete - In place	3000.00 CY	1,410,600	352,600	1,763,200	587.74
10- A/13.00.74/03	Reinforcing Steel	250000.00 LBS	300,500	75,100	375,600	1.50
10- A/13.00.74/04	Misc Struct Steel	8000.00 LBS	8,400	2,100	10,500	1.31
	Pumping Plant Substructure		1,719,500	429,900	2,149,300	
10- A/13.00.75	Pumping Plant Superstructure					
10- A/13.00.75/ 1	Superstructure		99,800	25,000	124,800	
	Pumping Plant Superstructure		99,800	25,000	124,800	
10- A/13.00.76	Pumping Machinery and Appurtenan					
10- A/13.00.76/01	Mechanical		440,800	110,200	551,000	
10- A/13.00.76/02	Station Cost		209,500	52,400	261,900	
10- A/13.00.76/03	Electrical		199,600	49,900	249,500	
10- A/13.00.76/04	Fuel Systems		239,600	59,900	299,400	
10- A/13.00.76/06	Formed Suction Intake		199,600	49,900	249,500	
	Pumping Machinery and Appurtenan		1,289,100	322,300	1,611,400	
10- A/13.00.99	Associated General Items					
10- A/13.00.99/ 1	Metals - Grating	800.00 SF	17,600	4,400	22,000	27.47
10- A/13.00.99/ 2	Metals - Handrail	400.00 LF	10,400	2,600	13,000	32.44
10- A/13.00.99/ 3	Gurardrail	300.00 LF	6,600	1,600	8,200	27.47
10- A/13.00.99/ 4	Staff Gages (2)		3,000	700	3,700	
10- A/13.00.99/ 5	Pavement	1500.00 SY	42,200	10,500	52,700	35.14

		QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
10- A/13.00.99/ 6	Emergency Steel Bulkhead		59,900	15,000	74,900	
10- A/13.00.99/ 7	Pickup Beam		5,000	1,200	6,200	
10- A/13.00.99/ 8	Access Road		10,000	2,500	12,500	
	Associated General Items		154,600	38,600	193,200	
	Pumping Plant		3,910,900	977,700	4,888,600	
	Pumping Plant		3,910,900	977,700	4,888,600	
	Construction Cost		3,948,800	987,200	4,936,000	
10- B	Non-Construction Cost					
10- B/30	Planning, Engineering and Design					
	Planning, Engineering and Design		315,900	79,000	394,900	
10- B/31	Construction Management (S&I)					
	Construction Management (S&I)		394,900	98,700	493,600	
	Non-Construction Cost		710,800	177,700	888,500	
	Structure 332C (300 cfs)		4,659,600	1,164,900	5,824,400	
11	Structure 332D (300 cfs)					
11- A	Construction Cost					
11- A/09	Channels and Canals					
11- A/09.02	Canals					
11- A/09.02.01	Mob, Demob & Preparatory Work					
11- A/09.02.01/ 1	Mob, Demob & Preparatory Work		2,600	600	3,200	
	Mob, Demob & Preparatory Work		2,600	600	3,200	
11- A/09.02.99	Associated General Items					
11- A/09.02.99/ 2	Clearing	1.00 ACR	2,200	600	2,800	2811.12
11- A/09.02.99/01	Excavation	2500.00 CY	10,100	2,500	12,700	5.07
	Associated General Items		12,400	3,100	15,500	

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
Canals		14,900	3,700	18,700	
Channels and Canals		14,900	3,700	18,700	
11- A/11 Levees and Floodwalls					
11- A/11.01 Levees					
11- A/11.01.01 Mob, Demob & Preparatory Work					
11- A/11.01.01/ 1 Mob, Demob & Preparatory Work		2,600	600	3,200	
Mob, Demob & Preparatory Work		2,600	600	3,200	
11- A/11.01.99 Associated General Items					
11- A/11.01.99/01 Embankment Fill	7500.00 CCY	18,600	4,600	23,200	3.10
11- A/11.01.99/02 Grassing	1.00 ACR	1,800	500	2,300	2263.74
Associated General Items		20,400	5,100	25,500	
Levees		23,000	5,700	28,700	
Levees and Floodwalls		23,000	5,700	28,700	
11- A/13 Pumping Plant					
11- A/13.00 Pumping Plant					
11- A/13.00.01 Mob, Demob & Preparatory Work					
11- A/13.00.01/ 1 Mob, Demob & Preparatory Work		162,300	40,600	202,800	
Mob, Demob & Preparatory Work		162,300	40,600	202,800	
11- A/13.00.03 Care and Diversion of Water					
11- A/13.00.03/01 Dewatering		219,600	54,900	274,500	
Care and Diversion of Water		219,600	54,900	274,500	
11- A/13.00.10 Earthwork for Structures					
11- A/13.00.10/01 Excavation	8000.00 CY	81,900	20,500	102,400	12.80
11- A/13.00.10/02 Fill and Backfill	7000.00 CY	81,900	20,500	102,300	14.62

		QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
11- A/13.00.10/03	Stone Protection	350.00 CY	19,800	4,900	24,700	70.61
11- A/13.00.10/04	Discharge Sumi Excavation	3000.00 CY	12,200	3,000	15,200	5.07
	Earthwork for Structures		195,700	48,900	244,600	
11- A/13.00.11	Foundation Work					
11- A/13.00.11/01	Steel Sheetpiling	2500.00 SF	70,300	17,600	87,900	35.14
	Foundation Work		70,300	17,600	87,900	
11- A/13.00.74	Pumping Plant Substructure					
11- A/13.00.74/01	Concrete - In place	3000.00 CY	1,410,600	352,600	1,763,200	587.74
11- A/13.00.74/03	Reinforcing Steel	250000.00 LBS	300,500	75,100	375,600	1.50
11- A/13.00.74/04	Misc Struct Steel	8000.00 LBS	8,400	2,100	10,500	1.31
	Pumping Plant Substructure		1,719,500	429,900	2,149,300	
11- A/13.00.75	Pumping Plant Superstructure					
11- A/13.00.75/ 1	Superstructure		99,800	25,000	124,800	
	Pumping Plant Superstructure		99,800	25,000	124,800	
11- A/13.00.76	Pumping Machinery and Appurtenan					
11- A/13.00.76/01	Mechanical		440,800	110,200	551,000	
11- A/13.00.76/02	Station Cost		209,500	52,400	261,900	
11- A/13.00.76/03	Electrical		199,600	49,900	249,500	
11- A/13.00.76/04	Fuel Systems		239,600	59,900	299,400	
11- A/13.00.76/06	Formed Suction Intake		199,600	49,900	249,500	
	Pumping Machinery and Appurtenan		1,289,100	322,300	1,611,400	
11- A/13.00.99	Associated General Items					
11- A/13.00.99/ 1	Metals - Grating	800.00 SF	17,600	4,400	22,000	27.47
11- A/13.00.99/ 2	Metals - Handrail	400.00 LF	10,400	2,600	13,000	32.44
11- A/13.00.99/ 3	Gurardrail	300.00 LF	6,600	1,600	8,200	27.47
11- A/13.00.99/ 4	Staff Gages (2)		3,000	700	3,700	
11- A/13.00.99/ 5	Pavement	1500.00 SY	42,200	10,500	52,700	35.14
11- A/13.00.99/ 6	Emergency Steel Bulkhead		59,900	15,000	74,900	
11- A/13.00.99/ 7	Pickup Beam		5,000	1,200	6,200	
11- A/13.00.99/ 8	Access Road		10,000	2,500	12,500	

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
Associated General Items		154,600	38,600	193,200	
Pumping Plant		3,910,900	977,700	4,888,600	
Pumping Plant		3,910,900	977,700	4,888,600	
Construction Cost		3,948,800	987,200	4,936,000	
11- B Non-Construction Cost					
11- B/30 Planning, Engineering and Design					
Planning, Engineering and Design		315,900	79,000	394,900	
11- B/31 Construction Management (S&I)					
Construction Management (S&I)		394,900	98,700	493,600	
Non-Construction Cost		710,800	177,700	888,500	
Structure 332D (300 cfs)		4,659,600	1,164,900	5,824,400	
12 State Road 9336 (Bridge)					
12- A Construction Costs					
12- A/09 Channels and Canals					
12- A/09.02 Canals					
12- A/09.02.01 Mob, Demob and Preparatory Work					
12- A/09.02.01/01 Mob, Demob and Preparatory Work		144,400	36,100	180,500	
Mob, Demob and Preparatory Work		144,400	36,100	180,500	
12- A/09.02.99 Associated General Items					
12- A/09.02.99/01 Pavement Removal - Causeway	4900.00 SY	43,900	11,000	54,800	11.19
12- A/09.02.99/02 Pavement Removal - Approaches	500.00 SY	4,500	1,100	5,600	11.19
12- A/09.02.99/03 Degrade Existing Causeway	10100.00 CY	107,700	26,900	134,600	13.33
12- A/09.02.99/04 Asphalt Pavement Approaches	500.00 SY	16,000	4,000	20,000	39.97
12- A/09.02.99/05 Box Culverts	44000.00 SF	2,634,900	658,700	3,293,600	74.85
12- A/09.02.99/06 Grassing		200	100	300	
Associated General Items		2,807,100	701,800	3,508,900	

		QUANTITY	UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
	Canals			2,951,500	737,900	3,689,400	
	Channels and Canals			2,951,500	737,900	3,689,400	
	Construction Costs			2,951,500	737,900	3,689,400	
12- B	Non-Construction Cost						
12- B/30	Planning, Engineering and Design						
	Planning, Engineering and Design			236,100	59,000	295,200	
12- B/31	Construction Management (S&I)						
	Construction Management (S&I)			295,200	73,800	368,900	
	Non-Construction Cost			531,300	132,800	664,100	
	State Road 9336 (Bridge)			3,482,800	870,700	4,353,400	
13	Connector Canal from C-111						
13- A	Construction Cost						
13- A/09	Channels and Canals						
13- A/09.02	Canals						
13- A/09.02.01	Mob, Demob & Preparatory Work						
13- A/09.02.01/01	Mob, Demob & Preparatory Work			86,900	21,700	108,600	
	Mob, Demob & Preparatory Work			86,900	21,700	108,600	
13- A/09.02.30	Bank Stabilization & Jetties						
13- A/09.02.30/01	Concrete	5000.00	CY	988,500	247,100	1,235,700	247.13
13- A/09.02.30/02	Reinforcing Steel	500000.00	LBS	601,000	150,200	751,200	1.50
13- A/09.02.30/03	Fill and Backfill	4333.00	CY	30,400	7,600	38,000	8.77
	Bank Stabilization & Jetties	2640.00	LF	1,619,900	405,000	2,024,900	767.00
13- A/09.02.99	Associated General Items						
13- A/09.02.99/01	Excavation	15800.00	CY	64,000	16,000	80,000	5.07

		QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
13- A/09.02.99/02	Clearing	2.00 ACR	2,200	600	2,800	1405.56
	Associated General Items		66,300	16,600	82,800	
	Canals		1,773,100	443,300	2,216,300	
	Channels and Canals		1,773,100	443,300	2,216,300	
	Construction Cost		1,773,100	443,300	2,216,300	
13- B	Non-Construction Cost					
13- B/30	Planning, Engineering and Design					
	Planning, Engineering and Design		141,900	35,500	177,300	
13- B/31	Construction Management (S&I)					
	Construction Management (S&I)		177,300	44,300	221,600	
	Non-Construction Cost		319,200	79,800	399,000	
	Connector Canal from C-111		2,092,200	523,100	2,615,300	
14	Connector Canal @ S-332B					
14- A	Construction Cost					
14- A/09	Channels and Canals					
14- A/09.02	Canals					
14- A/09.02.01	Mob, Demob & Preparatory Work					
14- A/09.02.01/01	Mob, Demob & Preparatory Work		86,900	21,700	108,600	
	Mob, Demob & Preparatory Work		86,900	21,700	108,600	
14- A/09.02.30	Bank Stabilization & Jetties					
14- A/09.02.30/01	Concrete	5000.00 CY	988,500	247,100	1,235,700	247.13
14- A/09.02.30/02	Reinforcing Steel	500000.00 LBS	601,000	150,200	751,200	1.50
14- A/09.02.30/03	Fill and Backfill	4333.00 CY	30,400	7,600	38,000	8.77
	Bank Stabilization & Jetties	2640.00 LF	1,619,900	405,000	2,024,900	767.00

		QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
14- A/09.02.99	Associated General Items					
14- A/09.02.99/01	Excavation	15800.00 CY	64,000	16,000	80,000	5.07
14- A/09.02.99/02	Clearing	2.00 ACR	2,200	600	2,800	1405.56
	Associated General Items		66,300	16,600	82,800	
	Canals		1,773,100	443,300	2,216,300	
	Channels and Canals		1,773,100	443,300	2,216,300	
	Construction Cost		1,773,100	443,300	2,216,300	
14- B	Non-Construction Cost					
14- B/30	Planning, Engineering and Design					
	Planning, Engineering and Design		141,900	35,500	177,300	
14- B/31	Construction Management (S&I)					
	Construction Management (S&I)		177,300	44,300	221,600	
	Non-Construction Cost		319,200	79,800	399,000	
	Connector Canal @ S-332B		2,092,200	523,100	2,615,300	
15	Connector Canal @ S-332C					
15- A	Construction Cost					
15- A/09	Channels and Canals					
15- A/09.02	Canals					
15- A/09.02.01	Mob, Demob & Preparatory Work					
15- A/09.02.01/01	Mob, Demob & Preparatory Work		86,900	21,700	108,600	
	Mob, Demob & Preparatory Work		86,900	21,700	108,600	
15- A/09.02.30	Bank Stabilization & Jetties					
15- A/09.02.30/01	Concrete	5000.00 CY	988,500	247,100	1,235,700	247.13
15- A/09.02.30/02	Reinforcing Steel	500000.00 LBS	601,000	150,200	751,200	1.50
15- A/09.02.30/03	Fill and Backfill	4333.00 CY	30,400	7,600	38,000	8.77

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
Bank Stabilization & Jetties	2640.00 LF	1,619,900	405,000	2,024,900	767.00
15- A/09.02.99 Associated General Items					
15- A/09.02.99/01 Excavation	15800.00 CY	64,000	16,000	80,000	5.07
15- A/09.02.99/02 Clearing	2.00 ACR	2,200	600	2,800	1405.56
Associated General Items		66,300	16,600	82,800	
Canals		1,773,100	443,300	2,216,300	
Channels and Canals		1,773,100	443,300	2,216,300	
Construction Cost		1,773,100	443,300	2,216,300	
15- B Non-Construction Cost					
15- B/30 Planning, Engineering and Design					
Planning, Engineering and Design		141,900	35,500	177,300	
15- B/31 Construction Management (S&I)					
Construction Management (S&I)		177,300	44,300	221,600	
Non-Construction Cost		319,200	79,800	399,000	
Connector Canal @ S-332C		2,092,200	523,100	2,615,300	
16 Canal L-31W (filled in) fr S-332					
16- A Construction Cost					
16- A/09 Channels and Canals					
16- A/09.02 Canals					
16- A/09.02.01 Mob, Demob & Preparatory Work					
16- A/09.02.01/01 Mob, Demob & Preparatory Work		109,900	27,500	137,300	
Mob, Demob & Preparatory Work		109,900	27,500	137,300	
16- A/09.02.99 Associated General Items					

		QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
16- A/09.02.99/01	Backfill	730000.00 CY	2,389,400	597,400	2,986,800	4.09
16- A/09.02.99/02	Clearing	50.00 ACR	56,200	14,100	70,300	1405.56
16- A/09.02.99/03	Grassing	4.00 ACR	7,200	1,800	9,100	2263.74
	Associated General Items		2,452,900	613,200	3,066,100	
	Canals		2,562,800	640,700	3,203,500	
	Channels and Canals		2,562,800	640,700	3,203,500	
	Construction Cost		2,562,800	640,700	3,203,500	
16- B	Non-Construction Cost					
16- B/30	Planning, Engineering and Design					
	Planning, Engineering and Design		205,000	51,300	256,300	
16- B/31	Construction Management (S&I)					
	Construction Management (S&I)		256,300	64,100	320,400	
	Non-Construction Cost		461,300	115,300	576,600	
	Canal L-31W (filled in) fr S-332		3,024,100	756,000	3,780,100	
17	C-111 North					
17- A	Construction Cost					
17- A/09	Channels and Canals					
17- A/09.02	Canals					
17- A/09.02.01	Mob, Demob & Preparatory Work					
17- A/09.02.01/01	Mob, Demob & Preparatory Work		46,000	11,500	57,500	
	Mob, Demob & Preparatory Work		46,000	11,500	57,500	
17- A/09.02.99	Associated General Items					
17- A/09.02.99/01	Excavation	248000.00 CY	1,005,000	251,200	1,256,200	5.07
17- A/09.02.99/02	Clearing	5.00 ACR	5,600	1,400	7,000	1405.56
	Associated General Items		1,010,600	252,600	1,263,200	

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
Canals		1,056,600	264,100	1,320,700	
Channels and Canals		1,056,600	264,100	1,320,700	
Construction Cost		1,056,600	264,100	1,320,700	
17- B Non-Construction Cost					
17- B/30 Planning, Engineering and Design					
Planning, Engineering and Design		84,500	21,100	105,700	
17- B/31 Construction Management (S&I)					
Construction Management (S&I)		105,700	26,400	132,100	
Non-Construction Cost		190,200	47,500	237,700	
C-111 North		1,246,800	311,700	1,558,500	
18 Canal C-109					
18- A Construction Cost					
18- A/09 Channels and Canals					
18- A/09.02 Canals					
18- A/09.02.01 Mob, Demob & Preparatory Work					
18- A/09.02.01/01 Mob, Demob & Preparatory Work		7,700	1,900	9,600	
Mob, Demob & Preparatory Work		7,700	1,900	9,600	
18- A/09.02.99 Associated General Items					
18- A/09.02.99/01 Plugs (10)	40000.00 CY	169,200	42,300	211,500	5.29
18- A/09.02.99/02 Clearing	4.50 ACR	5,100	1,300	6,300	1405.56
Associated General Items		174,300	43,600	217,900	
Canals		181,900	45,500	227,400	
Channels and Canals		181,900	45,500	227,400	
Construction Cost		181,900	45,500	227,400	

		QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
18- B	Non-Construction Cost					
18- B/30	Planning, Engineering and Design					
	Planning, Engineering and Design		14,600	3,600	18,200	
18- B/31	Construction Management (S&I)					
	Construction Management (S&I)		18,200	4,500	22,700	
	Non-Construction Cost		32,700	8,200	40,900	
	Canal C-109		214,700	53,700	268,400	
19	Canal C-110					
19- A	Construction Cost					
19- A/09	Channels and Canals					
19- A/09.02	Canals					
19- A/09.02.01	Mob, Demob & Preparatory Work					
19- A/09.02.01/01	Mob, Demob & Preparatory Work		7,700	1,900	9,600	
	Mob, Demob & Preparatory Work		7,700	1,900	9,600	
19- A/09.02.99	Associated General Items					
19- A/09.02.99/01	Plugs (10)	40000.00 CY	169,200	42,300	211,500	5.29
19- A/09.02.99/02	Clearing	4.50 ACR	9,600	2,400	11,900	2654.95
	Associated General Items		178,800	44,700	223,500	
	Canals		186,400	46,600	233,100	
	Channels and Canals		186,400	46,600	233,100	
	Construction Cost		186,400	46,600	233,100	
19- B	Non-Construction Cost					
19- B/30	Planning, Engineering and Design					
	Planning, Engineering and Design		14,900	3,700	18,600	

	QUANTITY	UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
19- B/31 Construction Management (S&I)						
Construction Management (S&I)			18,600	4,700	23,300	
Non-Construction Cost			33,600	8,400	41,900	
Canal C-110			220,000	55,000	275,000	
20 Canal C-111						
20- A Construction Cost						
20- A/09 Channels and Canals						
20- A/09.02 Canals						
20- A/09.02.01 Mob, Demob & Preparatory Work						
20- A/09.02.01/01 Mob, Demob & Preparatory Work			205,700	51,400	257,100	
Mob, Demob & Preparatory Work			205,700	51,400	257,100	
20- A/09.02.99 Associated General Items						
20- A/09.02.99/01 Excavation of Spoil Mounds	750000.00	CY	4,303,200	1,075,800	5,379,000	7.17
20- A/09.02.99/02 Clearing	1.00	ACR	1,100	300	1,400	1405.56
20- A/09.02.99/03 Grassing	1.00	ACR	1,800	500	2,300	2263.74
Associated General Items			4,306,200	1,076,500	5,382,700	
Canals			4,511,900	1,128,000	5,639,800	
Channels and Canals	1.00	EA	4,511,900	1,128,000	5,639,800	5639828
Construction Cost			4,511,900	1,128,000	5,639,800	
20- B Non-Construction Cost						
20- B/30 Planning, Engineering and Design						
Planning, Engineering and Design			361,000	90,200	451,200	
20- B/31 Construction Management (S&I)						
Construction Management (S&I)			451,200	112,800	564,000	

		QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
	Non-Construction Cost		812,100	203,000	1,015,200	
	Canal C-111		5,324,000	1,331,000	6,655,000	
21	Connector Canal from C-332A					
21- A	Construction Cost					
21- A/09	Channels and Canals					
21- A/09.02	Canals					
21- A/09.02.01	Mob, Demob & Preparatory Work					
21- A/09.02.01/01	Mob, Demob & Preparatory Work		86,900	21,700	108,600	
	Mob, Demob & Preparatory Work		86,900	21,700	108,600	
21- A/09.02.30	Bank Stabilization & Jetties					
21- A/09.02.30/01	Concrete	5000.00 CY	988,500	247,100	1,235,700	247.13
21- A/09.02.30/02	Reinforcing Steel	500000.00 LBS	601,000	150,200	751,200	1.50
21- A/09.02.30/03	Fill and Backfill	4333.00 CY	30,400	7,600	38,000	8.77
	Bank Stabilization & Jetties	2640.00 LF	1,619,900	405,000	2,024,900	767.00
21- A/09.02.99	Associated General Items					
21- A/09.02.99/01	Excavation	15800.00 CY	64,000	16,000	80,000	5.07
21- A/09.02.99/02	Clearing	2.00 ACR	2,200	600	2,800	1405.56
	Associated General Items		66,300	16,600	82,800	
	Canals		1,773,100	443,300	2,216,300	
	Channels and Canals		1,773,100	443,300	2,216,300	
	Construction Cost		1,773,100	443,300	2,216,300	
21- B	Non-Construction Cost					
21- B/30	Planning, Engineering and Design					
	Planning, Engineering and Design		141,900	35,500	177,300	
21- B/31	Construction Management (S&I)					

	QUANTITY	UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
Construction Management (S&I)			177,300	44,300	221,600	
Non-Construction Cost			319,200	79,800	399,000	
Connector Canal from C-332A			2,092,200	523,100	2,615,300	
22 Existing L-31W Borrow Cl-S332D						
22- A Construction Cost						
22- A/09 Channels and Canals						
22- A/09.02 Canals						
22- A/09.02.01 Mob, Demob & Preparatory Work						
22- A/09.02.01/01 Mob, Demob & Preparatory Work			84,200	21,100	105,300	
Mob, Demob & Preparatory Work			84,200	21,100	105,300	
22- A/09.02.30 Bank Stabilization & Jetties						
22- A/09.02.30/01 Concrete	5000.00	CY	988,500	247,100	1,235,700	247.13
22- A/09.02.30/02 Reinforcing Steel	500000.00	LBS	601,000	150,200	751,200	1.50
22- A/09.02.30/03 Fill and Backfill	4333.00	CY	30,400	7,600	38,000	8.77
Bank Stabilization & Jetties	2640.00	LF	1,619,900	405,000	2,024,900	767.00
Canals			1,704,100	426,000	2,130,200	
Channels and Canals			1,704,100	426,000	2,130,200	
Construction Cost			1,704,100	426,000	2,130,200	
22- B Non-Construction Cost						
22- B/30 Planning, Engineering and Design						
Planning, Engineering and Design			136,300	34,100	170,400	
22- B/31 Construction Management (S&I)						
Construction Management (S&I)			170,400	42,600	213,000	
Non-Construction Cost			306,700	76,700	383,400	

		QUANTITY	UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
	Existing L-31W Borrow Cl-S332D			2,010,900	502,700	2,513,600	
26	L-31W Tieback Levee						
26- A	Construction Cost						
26- A/11	Levees and Floodwalls						
26- A/11.01	Levees						
26- A/11.01.01	Mob, Demob & Preparatory Work						
26- A/11.01.01/01	Mob, Demob & Preparatory Work			56,200	14,100	70,300	
	Mob, Demob & Preparatory Work			56,200	14,100	70,300	
26- A/11.01.99	Associated General Items						
26- A/11.01.99/01	Embankment Fill	398265.00	CCY	987,000	246,700	1,233,700	3.10
26- A/11.01.99/02	Grassing	28.00	ACR	50,700	12,700	63,400	2263.74
26- A/11.01.99/03	Clearing and Grubbing	28.00	ACR	31,500	7,900	39,400	1405.56
	Associated General Items			1,069,100	267,300	1,336,400	
	Levees			1,125,400	281,300	1,406,700	
	Levees and Floodwalls	1.00	EA	1,125,400	281,300	1,406,700	1406706
	Construction Cost			1,125,400	281,300	1,406,700	
26- B	Non-Construction Cost						
26- B/30	Planning, Engineering and Design						
	Planning, Engineering and Design			90,000	22,500	112,500	
26- B/31	Construction Management (S&I)						
	Construction Management (S&I)			112,500	28,100	140,700	
	Non-Construction Cost			202,600	50,600	253,200	
	L-31W Tieback Levee			1,327,900	332,000	1,659,900	
28	Structure 332E (50 cfs)						

	QUANTITY	UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
28- A Construction Cost						
28- A/13 Pumping Plant						
28- A/13.00 Pumping Plant						
28- A/13.00.01 Mob, Demob & Preparatory Work						
28- A/13.00.01/01 Mob, Demob & Preparatory Work			37,100	9,300	46,300	
Mob, Demob & Preparatory Work			37,100	9,300	46,300	
28- A/13.00.03 Care and Diversion of Water						
28- A/13.00.03/01 Dewatering			109,800	27,500	137,300	
Care and Diversion of Water			109,800	27,500	137,300	
28- A/13.00.10 Earthwork for Structures						
28- A/13.00.10/01 Excavation	2700.00	CY	18,900	4,700	23,600	8.75
28- A/13.00.10/02 Fill and Backfill	4000.00	CY	28,900	7,200	36,100	9.03
28- A/13.00.10/03 Riprap Stone	120.00	CY	6,800	1,700	8,500	70.61
28- A/13.00.10/04 Bedding Stone	60.00	CY	2,800	700	3,400	57.31
Earthwork for Structures			57,300	14,300	71,700	
28- A/13.00.11 Foundation Work						
28- A/13.00.11/01 Steel Sheetpiling	1500.00	SF	42,200	10,500	52,700	35.14
Foundation Work			42,200	10,500	52,700	
28- A/13.00.74 Pumping Plant Substructure						
28- A/13.00.74/01 Concrete - In place	400.00	CY	188,100	47,000	235,100	587.74
28- A/13.00.74/03 Reinforcing Steel	30000.00	LBS	36,100	9,000	45,100	1.50
28- A/13.00.74/04 Misc Struct Steel	10000.00	LBS	10,500	2,600	13,100	1.31
28- A/13.00.74/05 Misc Steel	5000.00	LBS	3,800	1,000	4,800	0.96
Pumping Plant Substructure			238,500	59,600	298,100	
28- A/13.00.75 Pumping Plant Superstructure						
28- A/13.00.75/01 Superstructure			30,000	7,500	37,500	

		QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
	Pumping Plant Superstructure		30,000	7,500	37,500	
28- A/13.00.76 Pumping Machinery and Appurtenan						
28- A/13.00.76/01	Mechanical		156,000	39,000	195,000	
28- A/13.00.76/03	Electrical		31,900	8,000	39,900	
28- A/13.00.76/04	Operation		69,000	17,200	86,200	
	Pumping Machinery and Appurtenan		256,900	64,200	321,200	
28- A/13.00.99 Associated General Items						
28- A/13.00.99/01	Metals - Grating	300.00 SF	7,400	1,900	9,300	31.00
28- A/13.00.99/02	Metals - Handrail	100.00 LF	3,300	800	4,200	41.52
28- A/13.00.99/03	Guardrail	300.00 LF	4,400	1,100	5,500	18.24
28- A/13.00.99/04	Staff Gages (2)		3,800	1,000	4,800	
28- A/13.00.99/05	Pavement	1500.00 SY	40,800	10,200	51,000	33.98
28- A/13.00.99/06	Emergency Steel Bulkhead		25,000	6,300	31,300	
28- A/13.00.99/07	Pickup Beam		10,000	2,500	12,500	
28- A/13.00.99/08	Access Road		10,000	2,500	12,500	
28- A/13.00.99/09	Security Fencing	150.00 LF	5,300	1,300	6,600	44.28
	Associated General Items		110,100	27,500	137,600	
	Pumping Plant		881,900	220,500	1,102,300	
	Pumping Plant		881,900	220,500	1,102,300	
	Construction Cost		881,900	220,500	1,102,300	
28- B Non-Construction Cost						
28- B/01 Lands and Damages						
28- B/01.01 R/W						
	R/W	0.50 AC	2,500	600	3,100	6250.00
	Lands and Damages		2,500	600	3,100	
28- B/30 Planning, Engineering and Design						
	Planning, Engineering and Design		70,600	17,600	88,200	
28- B/31 Construction Management (S&I)						

	QUANTITY	UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
Construction Management (S&I)			88,200	22,000	110,200	
Non-Construction Cost			161,200	40,300	201,600	
Structure 332E (50 cfs)			1,043,100	260,800	1,303,900	
29 300' Spillway (Weir)						
29- A Construction Cost						
29- A/15 Floodway Control-Diversion Struc						
29- A/15.00 Floodway Control-Diversion Struc						
29- A/15.00.01 Mob, Demob & Preparatory Work						
29- A/15.00.01/01 Mob, Demob & Preparatory Work			3,900	1,000	4,900	
Mob, Demob & Preparatory Work			3,900	1,000	4,900	
29- A/15.00.10 Earthwork for Structures						
29- A/15.00.10/01 Excavation	1000.00	CY	3,300	800	4,200	4.18
29- A/15.00.10/03 Riprap Stone 2' Layer	900.00	CY	50,800	12,700	63,500	70.61
29- A/15.00.10/04 Bedding Stone 1' Layer	450.00	CY	20,600	5,200	25,800	57.31
Earthwork for Structures			74,800	18,700	93,500	
Floodway Control-Diversion Struc			78,700	19,700	98,400	
Floodway Control-Diversion Struc			78,700	19,700	98,400	
Construction Cost			78,700	19,700	98,400	
29- B Non-Construction Cost						
29- B/30 Planning, Engineering and Design						
Planning, Engineering and Design			6,300	1,600	7,800	
29- B/31 Construction Management (S&I)						
Construction Management (S&I)			7,800	2,000	9,800	
Non-Construction Cost			14,100	3,500	17,600	

		QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
	300' Spillway (Weir)		92,800	23,200	116,000	
30	S-332D Tieback Levee					
30- A	Construction Cost					
30- A/11	Levees and Floodwalls					
30- A/11.01	Levees					
30- A/11.01.01	Mob, Demob & Preparatory Work					
30- A/11.01.01/01	Mob, Demob & Preparatory Work		25,800	6,400	32,200	
	Mob, Demob & Preparatory Work		25,800	6,400	32,200	
30- A/11.01.99	Associated General Items					
30- A/11.01.99/01	Embankment Fill	166892.00 CCY	413,600	103,400	517,000	3.10
30- A/11.01.99/02	Grassing	28.00 ACR	50,700	12,700	63,400	2263.74
30- A/11.01.99/03	Clearing and Grubbing	28.00 ACR	31,500	7,900	39,400	1405.56
	Associated General Items		495,800	123,900	619,700	
	Levees		521,600	130,400	651,900	
	Levees and Floodwalls	1.00 EA	521,600	130,400	651,900	651942.70
	Construction Cost		521,600	130,400	651,900	
30- B	Non-Construction Cost					
30- B/30	Planning, Engineering and Design					
	Planning, Engineering and Design		41,700	10,400	52,200	
30- B/31	Construction Management (S&I)					
	Construction Management (S&I)		52,200	13,000	65,200	
	Non-Construction Cost		93,900	23,500	117,400	
	S-332D Tieback Levee		615,400	153,900	769,300	
40	Lands and Damages for C-111					

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
40- B Non-Construction Cost					
40- B/01 Lands and Damages					
40- B/01.01 Project Planning					
Project Planning		40,000	10,000	50,000	
40- B/01.02 Acquisitions					
40- B/01.02.01 By Local Sponsor					
By Local Sponsor		870,000	217,500	1,087,500	
40- B/01.02.04 Review of Local Sponsor					
Review of Local Sponsor		145,000	36,300	181,300	
Acquisitions		1,015,000	253,800	1,268,800	
40- B/01.03 Condemnation					
40- B/01.03.01 By Local Sponsor					
By Local Sponsor		1,000,000	250,000	1,250,000	
40- B/01.03.04 Review of Local Sponsor					
Review of Local Sponsor		100,000	25,000	125,000	
Condemnation		1,100,000	275,000	1,375,000	
40- B/01.05 Appraisals					
40- B/01.05.01 By Local Sponsor					
By Local Sponsor		435,000	108,800	543,800	
40- B/01.05.05 Review of Local Sponsor					

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
Review of Local Sponsor		116,000	29,000	145,000	
Appraisals		551,000	137,800	688,800	
40- B/01.06 PL 91-646 Assistance					
40- B/01.06.02 By Local Sponsor					
By Local Sponsor		12,000	3,000	15,000	
40- B/01.06.04 Review of Local Sponsor					
Review of Local Sponsor		1,200	300	1,500	
PL 91-646 Assistance		13,200	3,300	16,500	
40- B/01.07 Temporary Permits					
40- B/0T.07.01 By Local Sponsor					
By Local Sponsor		5,000	1,300	6,300	
40- B/01.07.04 Review of Local Sponsor					
Review of Local Sponsor		800	200	1,000	
40- B/01.07.06 Damage Claims					
Damage Claims		5,000	1,300	6,300	
Temporary Permits		10,800	2,700	13,500	
40- B/01.13 Draft PCA Review by CESAJ-RE					
Draft PCA Review by CESAJ-RE		2,000	500	2,500	
40- B/01.18 Real Estate Payments					

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
40- B/01.18.01 Land Payments					
Land Payments		37,730,000	9,432,500	47,162,500	
40- B/01.18.02 PL 91-646 Assistance Payments					
PL 91-646 Assistance Payments		90,000	22,500	112,500	
Real Estate Payments		37,820,000	9,455,000	47,275,000	
Lands and Damages		40,552,000	10,138,000	50,690,000	
Non-Construction Cost		40,552,000	10,138,000	50,690,000	
Lands and Damages for C-111		40,552,000	10,138,000	50,690,000	
41 Required Hydro & Bio Monitoring					
41- B Non-Construction Cost					
41- B/30 Engineering & Design					
Engineering & Design		6,400,000	1,600,000	8,000,000	
Non-Construction Cost		6,400,000	1,600,000	8,000,000	
Required Hydro & Bio Monitoring		6,400,000	1,600,000	8,000,000	
GRR Estimate for C-111 - Alt 6A		97,130,500	24,282,600	121,413,200	

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No errors detected...

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C-111
GENERAL REEVALUATION REPORT
Appendix E
Social and Economic Analysis

APPENDIX E

ECONOMIC ANALYSIS

C-111 GRR

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APPENDIX E
ECONOMIC ANALYSIS

INTRODUCTION

Purpose and Objectives - The purpose of this appendix is to evaluate the effects of alternative plans for the proposed water resources project in the C-111 basin. Information provided in this section includes the following:

a. A description of the study area.
b. The identification of the key economic activities in the study area and the determination of the extent and location of present land use and resource development in the area.
c. The discussion of impacts upon existing land use due to Hurricane Andrew and the development of a proposed future land use pattern in response to Hurricane Andrew.
d. The analysis of the effects of the proposed plan modifications to the existing water control system.

Description of the Study Area - The portion of the C-111 study area selected for economic studies includes the Taylor Slough basin, the Canal 111 basin and Levee 31 West. This area covers approximately 42,700 acres in southeastern Dade County. Generally, the study area lies west of U.S. 1, north and east of the Everglades National Park, and extends from SW 168th street (Grossman Drive) on the north side south to S-197. The Taylor Slough basin includes the area from S-331 at Grossman Drive south almost to Canal 103 at Southwest 264th Street. The Canal 111 basin and Levee 31 West extends further south past Structure 177, south west of Florida City. Existing land uses are primarily agricultural in the northern and central portion of the basin, with moderately urbanized areas near Florida City and Homestead. Ground level contours range from 1 to 10 feet NGVD with most of the active agricultural and urban land use on terrain 5 feet above NGVD. The southern-most portion of the basin at the 3.5-foot NGVD contour line is characterized by abandoned farmland and natural wetlands sloping gradually to Florida Bay.

Physical Characteristics of the Study area - Existing land use in the C-111 economic study area is predominately agricultural. In 1986, an estimated 36,700 acres were utilized for fruit tree groves, row and field crops and nurseries. There are two types of soil in the study area: limestone rockland, which accounts for most of the agricultural acreage, and marl soils. The rockland area extends roughly from U.S. 1 west to the Everglades Park boundary and from Tamiami Trail north of Grossman Drive, to Florida City and SR. 27 leading to the Everglades Park, on the south. Marl "East Glade" land generally lies east of U.S. 1 to the mangroves and south of Miami to the end of the mainland. This soil type is also found in the southern portion of the study area at elevations ranging from 0 to 4 feet above sea level.

Limestone rock is a relatively soft rock until it is exposed to the air. Many solution holes extend below the surface and act as storage places for water. Solution holes vary in diameter from a few inches to many feet, and may be 10-12 feet or more, in depth. Rockland is prepared for tree or vegetable crops by heavy tractors and scarifying equipment to "chisel" or "plow" this soil. Some 200 varieties of subtropical and tropical fruits are grown on the well-drained limestone rock soils of Dade County.

Marl is a dense, calcareous sedimentary soil deposited by water flowing from the northwest to the ocean. Since percolation for this soil type is slow, ditches and pumps are used to move excess water flows from marl areas to the ocean. Salt water control structures at canal outlets halt inward flow of sea water during periods when fresh water flow is inadequate to prevent salt water intrusion. Like rockland soils, marl soil areas are low in organic matter and require periodic applications of nutrient fertilizers such as nitrogen, phosphorous, and potash. Since most vegetable farming is done during the late fall and dry winter season, these crops can be grown on either rockland or low elevation marl soil areas. Potatoes and seed corn are major crops grown on marl land.

Problem Statement - Since initial project construction in the 1960's, damage susceptibility has increased due to the increased value of crops and agricultural encroachment which has taken place in the floodplain. Agricultural encroachment has occurred since the system has been operated at lower water levels than originally authorized. Two forms of encroachment are evident. First, highly damage susceptible vegetable crops can be grown year around rather than just in the dry winter months. Second, the amount of fruit tree crops and general horticultural activity have increased in the flood plain. Since these trees have longer root zones than other field crops, they are more susceptible to high water tables and to flooding.

Project Alternatives - All project alternatives are designed to provide increased flood protection when compared to the existing project operated at authorized levels in the economic study area and provide varying degrees of environmental restoration in the basin below this area. Eight alternatives have been selected for study. Each of the alternatives basically provide similar hydrologic and hydraulic responses, therefore, only one major economic investigation has been conducted. However, slight differences in flood damage effects for plans are noted since some of the plans require different quantities of land purchases in the Frog Pond area which is located in the south-west portion of the area. The effect of land purchases is to remove crop acreage from production and therefore reduce flood damage prevention benefits.

Risk Analysis - All plans include a flood control component which should approximately restore the authorized 10 year level of protection. The remaining features in Plans 1 through 6A achieve differing degrees of environmental restoration. Since the level of protection has not been changed from the authorized level, no risk evaluation has been performed for this study. In addition, the primary benefit category of inundation reduction is agriculture. Currently, there in no guidance or model available for this type of analysis and the compressed study schedule does not allow time for model development.

ANALYSIS OF ECONOMIC IMPACTS

Types of Impacts - The major impact being examined in this economic analysis is the variations in flood durations which adversely affect various types of active agricultural acreage in the study area. Specifically, water tolerances of Dade County crops (vegetables, tropical fruit trees, and nursery stock) in floodprone areas are measured using expected flood durations from varying flood frequency situations to determine crop damages. These damages are generally measured by the loss in operating and fixed costs sustained by growers even if they are covered by crop insurance. Damages are computed for various frequency flood events and converted to an average annual basis. Tree crops and nurseries are susceptible to damage at any time during the year. Damage to seasonal crops is adjusted using the cumulative percentage of production costs invested during any given month in the growing season and the percent chance of monthly occurrence of a damaging flood event.

The evaluation of flood damage impacts has been conducted at two separate points in time. The first evaluation consists of an analysis of plan impacts on land use development physically existing in the study area in the base year 2001. The second evaluation was an analysis of the impacts on land use development in the year 2006. Differences in damage susceptibility are solely due to assumptions concerning differing stages of maturity of new fruit trees expected to be planted after Hurricane Andrew. Other changes in land use are not expected after the year 2006. Project life impacts are amortized and discounted during the fifty year period and converted to an average annual equivalent.

Flood damage susceptibility is measured without and with proposed alternatives. The differences represent the inundation reduction benefits of the proposed project. A more detailed explanation of the procedures used in the determination of these damage estimates is presented in a later section.

1986 Land Use - In the 1970's and 80's, there had been increased agricultural and urban development in the Homestead - Florida City area. The pace of cropland development in the northern portions of the C-111 basin had been especially rapid. While total agricultural acreage had increased, there had been a relatively more extensive development of tropical fruit groves and ornamental horticulture than in seasonal vegetable row crops. As a result, land values have increased as well as the potential damages that may occur from periodic flooding. There was and is now approximately 42,700 acres of land within the economic study area boundaries of which approximately 36,800 acres or 86 percent are utilized for agricultural purposes. Tropical fruit groves and nurseries in 1986 covered approximately 13,600 acres. Vegetable tracts, field crops, and fallow areas account for the remaining acreage. Some 5,900 acres of nonagricultural land were comprised of residential tracts, recreational areas, marginal wetlands, and undeveloped open land. Study area land use acreages are displayed in table 1.

Existing (1993) Land Use - The original tabulation of land use acreage in the C-111 basin was conducted in 1986. Since that time Hurricane Andrew has impacted all of South Florida with greatest concentration in the Homestead and Florida City area. Interviews with representatives of the Institute for Food and Agricultural Sciences, and the Dade County Extension Service have indicated that the agricultural area is recovering quickly after the event. None of the fruit growers have left the area after Hurricane Andrew and no additional acreage since Hurricane Andrew is currently fallow due to the storm. Also, no reductions in vegetable crop production per acre have been recorded. Approximately, sixty percent of the property used for vegetable crops is rental property and many of the areas were used for burning debris immediately following the storm.

Since Hurricane Andrew was a wind-driven rather than a rain-driven storm, tree crops were severely affected in the study area. The Florida Agricultural Statistics Service in Orlando has reported for all of Dade County that there has been a 34 percent decrease of avocado acreage in the Dade County area from 8,987 acres in 1990 to 5,965 acres in 1993. Limes were down over 70% from the 6,071 acres reported in Dade in 1990 and mangos had decreased over 40 percent to 1,398 acres. It can be assumed that a significant portion of this decrease is due to Hurricane Andrew. In the study area portion of C-111, productive fruit tree crop acreage has decreased, particularly east of L-31N. It is believed that many of the remaining trees east of L-31N and L-31W may not survive. West of L-31N, much of the fruit tree acreage is either unaffected or has been replanted. Productive acreage west of L-31N is considered to be incompatible with optimum stage regulation authorized by the original flood control project. Plan alternatives which worsen conditions over optimum stage levels in this area include the purchase of these lands as a project component. Therefore flood damage effects to this land use are not considered.

The 1993 land use condition was prepared using detailed crop information provided by the firm of Larsen and Associates[1] as a guide. Other sources utilized included 1990 land use Cad-drawings provided by the Dade County Planning Department recorded before Hurricane Andrew at approximately land use classification LUDA Level II, and 1992 aerial photographs from the REDI (Real Estate Information Service) located in Ft. Lauderdale. In addition, two field investigations were conducted solely to locate fruit groves that were destroyed by Hurricane Andrew and to generally update field crop land use information in the study area. Agencies contacted include the Dade County Extension Service, the Agricultural Stabilization and Conservation Service (USDA), the Dade County Tax Assessor's Office, the Department of Environmental Management, and the Metropolitan Dade County Planning Department.

Updated land use information was collected, however, the specific location of downed fruit groves due to Hurricane Andrew was not determined. Therefore, percentages of downed fruit trees for Dade County reported by the Florida Agricultural Statistics Service in Orlando are used in this study. These percentages have been proportionally distributed among all the fruit tree acreage in the study area. After the storm, downed groves were replanted mainly in mixed vegetables. This interim decision allows immediate income production while landowners decide whether or not to replant fruit trees. The 1993 land use condition has been constructed to display the appropriate acreage of downed fruit trees in the mixed vegetable land use classification.

[1] Larsen and Associates is a consulting environmental engineering firm located in Miami, Florida.

Future Land Use (General) - Projections of future land use in the study area would indicate some growth in agricultural acreage and in residential areas. Tracts utilized for tropical fruit groves, Cuban vegetables, specifically guava and papaya, and ornamental horticulture are expected to replace some acreage used for traditional vegetables such as tomatoes, beans, corn, and squash. Market price is excellent for these commodities, production practices are improving and new methods have been developed to make these crops more disease resistent. South Florida Lime production should not be significantly affected by the increased importation of Mexican limes as a result of the North American Free Trade Agreement. Although, 95% of U.S. limes are produced in South Florida, Mexican limes currently have no rigid standards for production or export and are inferior in quality and durability.

Open rockland soil areas bordered by C-111, L-31W, and SR. 27 will continue to be utilized for nontropical row crops, particularly tomatoes. Urban development around Homestead and Florida City should show controlled growth of low to low-medium density residential areas with an upper limit of 13 dwelling units per acre. New residential development should include single family homes, townhouses, or small apartments after recovery from Hurricane Andrew. Future residential, commercial and industrial land use is not projected to significantly affect existing agricultural land in the study area. Unless environmental restrictions change this land use from agriculture to wetland, no further change is expected throughout the project life.

Base Condition (2001) and 2006 Land Use - The 2001 land use condition reflects damage susceptibility at the beginning of the project life. The major differences between the 1993 and 2001 land uses will be the replanting of fruit trees. Two effects are expected to occur with replanting. First, the mixed vegetables currently being grown in the groves will disappear. Second, the new fruit trees will begin to experience damage susceptibility to flood events.

At present, an exact estimate of the acreage of fruit trees that will be replanted is unknown. Most of the fruit crop acreage affected by Hurricane Andrew has been replanted west of the levee. East of the levee, discussions with the Dade County Extension Office and the United States Department of Agriculture (USDA) indicate that 50% to 100% of the trees will be replanted. This analysis assumes that by 1996, 50% of the downed fruit tree acreage will be replanted. During the (1993-1996) time frame when all re-planting is estimated to be completed, there will be no damage susceptibility to this acreage. Major fruit trees expected to be replanted in the basin include lychee, limes, avocadoes, mangos, papaya, carambola, longan, and guava. Major fruit crops which are especially flood damage susceptible include; limes, avocadoes, mangos, and papaya. Generally, fruit trees require 4-5 years before bearing fruit, and 8-12 years to achieve full production. Therefore after 5 years at the beginning of the project life in 2001, it is assumed all new trees will be mature, however, no fruit will currently be produced. Flood damage assessment in this time period will be assessed using the full value of the tree but no damage is claimed for fruit losses. At the end of 10 years in the year 2006, it is assumed all fruit trees will be fully mature and fruit production has returned to normal. Flood damage susceptibility now will affect fruit as well as trees. Flood damage susceptibility is expected to remain the same from the years 2006-2051. Study area land use acreages expected in the year 2001 are displayed in table 2.

Frog Pond Land Use - It is not rational to expect growers to plant areas in the Frog Pond where the topography would be below normal operating stages. Optimum operating stages at authorized levels at S-332 and the surrounding area are expected to be approximately 3.75ft. msl. on the average for the without project condition. Plan alternatives would not significantly change this elevation. Although seasonal regulation schedules will not be formulated in this report, it is assumed given the environmental nature of the formulation that maximum flexibility will be required in maintaining high water levels for the express purpose of producing the highest quality environmental wetlands. At these levels, entry via State Road 9336 will be possible which should allow entry of heavy equipment and allow the rock-plowing necessary for the preparation of all land above 4.25 feet. It is assumed all productive land at or below 4.25 feet msl. will not be able to be used in a productive capacity in the Frog Pond or in the area below the Frog Pond adjacent (west) of C-111. The current land use grown in the area is predominately tomatoes.

Analysis Methodology

General Methodology - Flood damage analysis for the C-111 study area is focused primarily on agriculture production. For the flood damage evaluation, six different flood frequencies were used with durations ranging from no flooding to 25 or more days. The frequencies of these floods are the Standard Project Flood (SPF which is estimated to be equalled or exceeded once every 250 years), 100-year, 50-year, 25-year, 10-year, and the 2-year. Elevation-duration relationships were constructed for each one square mile cell. The adjusted topographic elevation for each parcel of land use was retrieved, flood durations were computed and flood damages were estimated. To determine flood damages for varying flooding frequencies, it was necessary to obtain specific land use data, measure the extent of flooded acreage by crop type and flood duration, and apply per acre damage estimates for each crop to plot frequency-damage curves and calculate average annual damages. This procedure is discussed in detail in the following paragraphs.

Land Use and Topography - Land use data was compiled for the 2001 and 2006 land use conditions as discussed earlier and was sub-divided into one square mile grid cells. Topographic information was recorded using USGS quadrangle sheets with 5 foot contour intervals using one foot interpolation. Limited topographic coverage was available from the Everglades Drainage District in 1939. These maps provided 1/2 foot contour intervals in the south portion of the basin. In addition, topographic coverage of the Frog Pond was provided for the South Dade Land Corporation by Ghioto and Associates in 1988. Inside each square mile cell, acreages were recorded by land use classification and topographic elevation. For agricultural land use, acreage totals were reduced by 10% to allow for infrastructure (road, canal, and levee areas) and again by approximately 4% to account for fallow agricultural land inside each ownership.

General Agricultural Damage Susceptibility

— Root Zone Depth - For agricultural land use, it is assumed damage susceptibility begins when water reaches the bottom of the root zone. Therefore, it is necessary to know the depth of root zones and water tolerances for individual tree and row crops in the rockland and marl soils of the study area. Vegetable crops have root depths of 6 to 12 inches. A root length of 8 inches has been selected for this study. Root zones for fruit trees are deeper than row crops, generally ranging from 12 to 30 inches deep. A root length of 18 inches has been selected for limes, avocados, and mangos and a 12 inch root length has been selected for papaya. Root depths for field nursery plants vary from 2 feet to 4 feet. A 2 foot root depth is used in this analysis. For all other nursery classifications, it is assumed all plants are in containers and the containers are at ground level. It is also assumed that all plants in containers and not elevated incur damage during a flood.

Bedding Heights - It is assumed all vegetable crops are planted on beds. The average bed height is estimated to be 6 inches. Fruit trees are planted on beds and bed heights range from 12 to 30 inches. An average compacted height of 16 to 18 inches is considered reasonable and a 17 inch bedding elevation is used for all fruit trees in this analysis. For lack of better information, all field nursery plants in this analysis will also use a 17 inch bedding elevation. Root zone damage susceptibility is computed by adding the bedding height to the topographic elevation and subtracting the root zone depth for the appropriate vegetable crop or fruit tree. For example, all vegetable crop damage susceptibility will begin when floodwaters are 2 inches below the recorded topographic elevation. Detailed agricultural land use classifications, root depths and average bedding heights are displayed in table 3. Fruit crop damage susceptibility will vary depending upon root depth as shown in table 4.

Vegetable and Fruit Crops Damage Susceptibility

Production Costs per Acre - A conservative estimate of the value of vegetables in the ground can be approximated by using operating costs, fixed costs, and land rental values to produce the crop. Operating costs include seeds or transplants, fertilizers and pesticides, labor, interest, and machinery expenses. Fixed costs include land rents, depreciation, licenses, and insurance. Excluded from loss estimates are harvesting and marketing costs and any share of net returns to the grower which are derived from total receipts less total costs. Vegetable Summaries provided by the Institute for Food and Agricultural Sciences for the South Dade area and Everglades Agricultural area provide fixed cost, operating costs, and land rent estimates for most vegetable crops in the C-111 basin. This information is utilized to compute flood damage potential for these crops. Sufficient information was not available to use any normalized procedure for costs. For land use classifications 1 through 11 in table 3, the values in table 5 represent a simple 5 year average of operating costs, fixed costs and land rental information transcribed from economic information reports for production costs produced by IFAS.[2] These values are used to compute a maximum potential loss per acre for each vegetable crop.

The Dade County Extension Service provided information concerning production costs, fixed costs and land rental for pole beans, sweet potatoes, malanga, calabaza, and yuca. Fruit crop losses include losses of production costs and tree replanting operating and fixed costs estimated for non-bearing periods when the tree is replanted. All fruit crop production cost information was provided by the Dade County Extension Service. A summary of potential fruit crop losses on a per acre basis is shown in table 6.

Duration-Damage Relationships - Losses to vegetable and fruit crops are very much dependent upon the duration of flooding in root zones. Put simply, crop damage is caused by the crops inability to breath and the associated diseases which occur due to the growth of micro-organisms when aerobic activity is replaced by anaerobic activity due to lack of oxygen and CO_2. Discussions with knowledgeable sources have indicated that damage begins immediately after water enters the root zone and continues until maximum loss occurs as shown in table 7. Expected losses during time frames between the initial flooding and total plant mortality are computed using a linear relationship. The actual period when losses will occur is also dependent upon whether or not water in the root zones is moving or stagnant during the flood and whether root zones are continuously or intermittently flooded.

As shown in table 5, vegetable crops, with the exception of potatoes, are generally lost after 12 hours of inundation. Water inundation tolerances show considerable variance for citrus and tropical fruit trees. Periods of inundation that will cause fruit loss and, if extended, cause root damage and tree loss are shown in table 7. Short water inundation tolerance periods for avocados and papaya trees make these crops highly vulnerable in flooding situations.

Horticulture - Horticulture activity in Dade County has been classified as either foliage, woody ornamentals, or field nurseries. In 1984-85 it was estimated that approximately 55% of total sales was foliage, 15% was woody ornamental, and 30% was field nurseries. In addition, 38.7% of the acreage in production was classified as foliage nurseries, 12.9% as woody ornamentals and 48.3% as field nurseries. These percentages are used as weights to determine flood damage susceptibility for these crops in the Canal 111 basin. Horticultural plants grown in the C-111 basin are shown in table 8.

A conservative measure of the loss that would occur with any flood would be the loss of production costs necessary to produce the crop. The total dollar value of horticultural crops in 1983-84 and acreage in production in the South Dade area is shown in table 9. It is estimated that the value of crops increased by approximately 20% from 83-84 to 1986.[3] The value per acre computed in 1986 is used in the current analysis to represent a conservative estimate of the total

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[2] Economic Information Reports 245, 257, 273, EI 91-2 and Circular 1064. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville.

[3] Estimates provided by representatives of nursery sales outlets in Homestead.

value of the crop in the ground that could be damaged with a given flood. The production costs associated with these sales have been estimated to be 89.7% for foliage nurseries, 89.5% for woody ornamentals and 81.8% for field nurseries.[4] It is assumed there would be sufficient warning time to protect some of the foliage nursery and woody ornamental plants. Protection may be as simple as providing covered shelter on site and elevating the plants a foot or two above the ground. In some cases protection may not be possible. The evaluation assumes 30% of the foliage plants and 15% of the woody ornamental plants can be protected against the flood. Duration-percent damage for each classification was estimated using empirical information gathered from local growers during the 1986 flood. A composite damage relationship for horticulture is shown in table 10.

<u>Seasonal Flood Damage Potential to Field Crops</u> - Fruit trees and horticulture crops grow and produce year around. Therefore, they are susceptible to flooding throughout the year. Field crops have specific planting, growing, and harvesting periods and are susceptible only on a seasonal basis. There are many methods of compensating for seasonal probabilities of flooding. In this evaluation annual series of flooding probabilities are adjusted to determine the percent chance of occurrence of a damaging flood in any given month. In addition, it is necessary to determine the flood damage susceptibility of vegetable crops by month during the growing and harvest seasons. Since production costs are being used to determine the loss, it was necessary to estimate the cumulative value of production costs that would be lost if the flood occurred during any given month. Due to the amount of information and calculations required, no attempt is made to determine this relationship for all vegetable crop classifications in the basin. Tomato crops are the major crop of interest. Calculated tomato crop damage under varying storm conditions ranges from approximately 64% to 91% of total full production vegetable crop damages with the larger percentages occurring for the more frequent storm events. Therefore, seasonal adjustments computed for tomatoes are used for all full production vegetable crop damage estimates.

The method used to estimate the cumulative value of production costs that would be lost during any given month required the computation of daily percentages of total production cost estimates that would be expended before harvest. A daily production scenario was developed using the following general assumptions:

a. Field interviews indicate that approximately only 20% of tomato acreage is currently double cropped for tomatoes. Therefore, only single crop production costs are used in the analysis although it is likely that more double cropping could be expected in the future. Second crops other than tomatoes are usually either squash or cucumbers. In some cases, a cover crop may be grown during the rest of the year. Damage susceptibility to these crops are slight and is not considered.

b. Total tomato acreage in the basin is planted only once per year but picked three times per year. This means a given owner may plant only 1/3

[4]Information computed from the Economic Information Report EI 92-1r, "Business Analysis of Ornamental Plant Nurseries in Florida, 1990", IFAS, University of Florida, May 1992.

of his acreage at a time. The analysis assumes there are three groups of planters; early season, mid-season, and late season planters. Each group of planters plant 1/3 of their acreage at a time with an average 10 day delay between plantings. There is a 60 day interval between early season, mid-season, and late season planters. The entire season for planting, growing and harvesting will extend from mid-august to mid-april.

c. The actual growing period is approximately 85-120 days between 1 September and 31 December. There is a 60-70 day growth period for tomatoes between planting and harvesting. This evaluation assumes a 70 day growth period.

d. The analysis assumes that 2 weeks of land preparation are required before the growing season. Land preparation includes cleanup, soil treatment, insecticides, fertilizers, discing and rock-plowing. At this time, some production costs are expended. Losses can occur due to delays in planting.

e. The analysis assumes that land preparation costs are approximately 31% of total production costs. 1991-92 production costs for tomatoes are shown in table 11. The remaining costs are proportionately distributed on a daily basis to the growing period. The evaluation assumes all remaining growth of production costs are linear until the end of the growth period.

f. The analysis assumes a 14 day harvest period.

g. The analysis assumes after the growth period during harvesting, production costs decrease in a linear fashion until all production is harvested at the end of the harvest period.

h. Computed costs for each group of growers for each function are summed on a daily basis. A simple monthly average of the daily data is then computed.

Simplified sample calculations of the entire process are shown in table 12. Monthly probabilities of flooding and cumulative percentages of total production costs expended for field crops are shown in table 13.

Urban Damage Susceptibility - Urban land uses susceptible to flood damage in the basin include single family residential housing and mobiles homes. Damage to residential structures and personal property is a function of the peak stage of the flood. Damage to residential lawns, pavement, shrubs and streets is a function of the duration of the flood. A formal appraisal of structure value was not undertaken in the study area since residential damage was not the major focus of the evaluation. However, informal discussions with realtors in the area and site inspections revealed that average values for residential structures and mobile homes of $60,000 and $20,000 are reasonable. Residential development in the basin consists of single family estate homes and planned developments with densities of development at less than 1 per acre and approximately 4 to 5 per acre respectively. Mobile homes are mainly concentrated in a few mobile home parks. A density of 2 homes per acre for all single family development and 5 homes per acre for mobile homes are used in this study. First floor elevations are approximately 1 foot for single family residential and 3 feet for mobile homes. Personal property or content value is estimated at 40% of the value of the structure. Estimates of depth-damage for single family residential and mobile homes structure and content damage were produced by the Federal Emergency Management Agency (FEMA) in 1992 for the nation. FEMA data for Florida is not used due to sample inadequacy and resulting inconsistencies in the form of the damage relationship.

Homes in the area have reasonable amounts of landscaping. To compute damages to lawns, pavement, shrubs and streets, the following assumptions are made after review of aerial photographs and a field inspection:

1. Residential lawns - Quality of lawns range from fair to good. Structural size is approximately one-third of the total lot size basin wide for all residential except for single family estates and mobile homes. Therefore, for all single family land use, lawn size is assumed to be a function of structure size and lawn size is approximately twice as large as the structure. One-half of the lawn size in a single family residence is used for mobile homes damage calculations. These damage relationships are used basin wide.

2. Residential shrubs - The number, quality, and maturity of shrubbery on residential lots was estimated using field information and photographs. Then, it was assumed that the number of shrubs on a residential lot is directly proportional to lawn size and therefore to structure size. Little shrubbery is associated with mobile homes, therefore, no shrub damage potential is evaluated for this land use classification. The single family residential damage relationship for shrubs is used basin wide.

3. Residential pavement - It is assumed that the amount of pavement required for a single family residence is fairly standard and not a function of lot and structure size. Quantities of pavement used for driveways, sidewalks and walkways were estimated from field observations. Since most mobile homes are higher density, 1/2 of the single family residence relationship is used for damage calculations. These damage relationships are used basin wide.

4. Residential streets - The linear footage of streets in a residential area is not a function of structure size. Street lengths in other low density residential areas have been measured on aerial photographs and found to approximately 140 linear feet per acre of development. The damage relationship derived from this information is adjusted by residential land use densities to produce estimates of street damage by structure. These damage relationships are used basin wide.

Inundation Reduction Analysis

<u>Existing Damage Potential, Without-Project. (No Frog Pond Land Purchases) -</u> For land use conditions expected in the year 2001, flood damages adjusted for

seasonal probabilities are expected to flood in excess of 31,700 acres and cause approximately $93.6 million in damage during a Standard Project Storm. A 2 year frequency storm is expected to flood in excess of 4,500 acres and cause approximately $2.3 million in damage. Floodprone areas without the project and for alternative conditions are shown in tables 14 and 15[5] and in figures E-1 and E-2.[6] Fruit tree crops incur only minimal damage susceptibility for floods at the 10 year level or less. For fruit trees, flood damages are expected to range from $51.5 million during a Standard Project Storm to $1.5 million during a 10 year storm. For these floods limes, avocados, and mangoes are affected with avocados incurring over 90% of fruit crop damage. The high damage susceptibility for avocados reflect the long time to grow a mature replacement tree after a flood and the relatively low water tolerance period for avocado root systems, which allow tree loss after 24 hours of inundation. Conversely, mangos and lime tree groves incurred less damage due to higher water tolerances. Fruit crop damage potential is shown in table 16.

Nurseries show high damage susceptibility due to several factors. Like fruit trees, root zones can be 2 to 4 feet long which makes them highly vulnerable to underground flooding. In addition, short term durations can cause total losses to foliage and woody ornamental plants since the public will not except any of these plants that are blemished or marred. Damage potential to nurseries are also shown in table 16.

Urban damage potential includes damage to urban structures, contents and lawns, pavements, shrubs, and streets. All of the damage below a 25 year event is basically flooding to lawns, pavement, shrubs, and streets caused by the duration of the event. Given most single family residences have a one foot first floor elevation, water is not expected to enter residences except for the rarer flood frequencies at the 25 year interval or greater. Mobile home flood damage is minimal since most first floor elevations are 3 feet or greater. Urban damage potential is also shown in table 16.

Vegetable crops have a high potential for damage if a large flood event occurs just prior to harvest. As discussed earlier, virtually all vegetable row

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[5] Acreage in tables 14 and 15 are cataloged as floodprone when flood elevations are above ground level. Affected field crop acreage may be less than shown depending upon the growing season of the crop and the seasonal occurrence of the flood.

[6] Notes concerning figures E-1 and E-2 are as follows:

- Floodprone area delineation represents when damage susceptibility occurs in a cell and not necessarily when flooding above ground exists and no damage susceptible land use is located.

- Topographic information is adjusted by bedding heights and root depths for fruit and vegetable crops. Damage susceptibility can occur at elevations from 2 to 7 inches underground.

- Representation of damage susceptibility indicates damage exists in a cell. It does not indicate that the entire cell is flooded nor does it represent the magnitude of flooding.

- Floodprone area delineation based upon vegetable crop damage susceptibility is dependent upon the seasonal occurrence of flooding.

- Spatial allocation of flooding for alternative conditions is similar to without project although the magnitudes of damage susceptibility are less.

crops are lost after 12 or more hours of flooding with the exception of potatoes with a 24-hour damage threshold. Tomatoes, which account for the highest production value of vegetable row crops in the study area, consistently incurred the largest dollar damages during any flood frequency. Snap beans and mixed vegetables, the leading vegetable crops in terms of acreage, ranked second in damage value during various flooding events. Seasonally unadjusted full production flood damages for vegetable crops are shown in table 17. However, an examination of table 13 indicates that if growers continue current growing practices during the winter months, flood damage susceptibility can be substantially reduced.

Seasonally adjusted damage estimates for vegetable crops are added to nursery, fruit crop and urban damage for each frequency flood. The result is total expected damage by frequency for the without project condition at the beginning of the project life (2001). These results are shown in table 18.

After total damage estimates are tabulated for each frequency flood, probability of occurrence is defined for selected floods on the basis that the flood could be equaled or exceeded in a given year. Flood frequencies and damage estimates are then combined to produce a frequency-damage curve. The frequency-damage curve is integrated to produce average annual flood damages for the 2001 without project condition. Average annual damages are expected to be $5,366,800 with no frog pond purchases, $5,157,600 with the west 1/2 of the frog pond removed from production and $4,698,600 with the entire frog pond removed from production.

Future Damage Potential, Without-Project (No Frog Pond Land Purchases). As discussed previously, the evaluation of impacts on land use development in the year 2006 was also investigated. Differences in damage susceptibility are due to assumptions concerning differing stages of maturity of new fruit trees planted after Hurricane Andrew. Fruit trees generally require 4-5 years before bearing fruit, and 8-12 years to achieve full production. Therefore if replanting is completed by 1996, after approximately 5 years at the beginning of the project life in 2001, fruit trees will be mature and ready to bear fruit. At this time, flood damage is assessed using the full value of the tree. However, no marketable fruit is produced at this point and no damage is claimed for fruit losses. At the end of 10 years in the year 2006, it is assumed all fruit trees will be fully mature and producing fruit at pre-Andrew capacity. At this time, flood damage is assessed using the full value of the fruit and tree. Flood damage susceptibility will remain the same from the years 2006-2051. Total expected damage by frequency for the without project condition for the period 2006-2051 are shown in table 19. Average annual damages for the 2006-2051 without project condition are expected to be $5,560,500 with no frog pond purchases, $5,271,800 with the west 1/2 of the frog pond removed from production and $5,008,500 with the entire frog pond removed from production.

The future annual increase in flood damages is amortized and discounted at 8%, 6% and 2 1/2% to calculate an average annual equivalent. The result of this analysis is average annual equivalent flood damages for the without project condition. Average annual equivalent damages without the project with no frog pond purchases are estimated to be $5,533,300 at 8%, $5,538,600 at 6%, and $5,547,500 at 2 1/2%.

Plan Alternatives - Eight alternatives have been selected for study. Each of the alternatives basically provide similar hydrologic and hydraulic responses. Slight changes in flood damage effects are noted since some of the plans require different quantities of land purchases in the Frog Pond area located in the south-west portion of the economic area. The effect of land purchases is to remove crop acreage from production and therefore reduce flood damage prevention benefits. Plan 1 requires no land purchases in the Frog Pond Area. Plan 2 is evaluated with the west 1/2 of the Frog Pond removed. Plans 3, 4, 5, 6, and 6A are evaluated with the entire Frog Pond removed. Plan 1A is essentially the same as Plan 1 with the exception that environmental features are reduced to a level of minimum acceptability. Evaluations indicated that the all alternatives would improve flood drainage in the study area and substantially reduce flooding durations, dollar damages, and crop land flooded during the 10 year and 2 year storm events.

Existing Damage Potential, Plan 1 and Plan 1A - The hydrologic results occurring from the Standard Project Flood, 100-year, 50-year, 25-year,10-year, and 2-year flood frequencies were used to estimate damages using alternative project conditions. The same procedures as discussed for without project conditions were utilized to measure the damage susceptibility of the proposed project.

The proposed project virtually eliminates flooding and crop damage during a 2-year storm, and generally provides slightly less than 10 year protection. Effects upon benefits are most significant for the 10 year and more frequent flood events. An evaluation of damage reduction benefits indicates a virtual absence of damage to fruit trees and nurseries, minor damage to vegetable crops, and only minor damage to urban lawns, pavement, shrubs, streets with a 10-year or more frequent flood event. For 25-year and more severe storms, the proposed project would benefit fruit tree and ornamental nurseries substantially more than row crops. This primarily reflects a significant reduction in flooding on tracts utilized for avocado groves and nurseries where flood damages can be significant. Flood damage susceptibility for the Plan 1 and Plan 1A condition in the year 2001 is shown in tables 20, 21, and 22. Average annual damage with Plan 1 and Plan 1A is expected to be $2,310,300.

Future Damage Potential, Plan 1 and Plan 1A - Flood damage potential for this condition is computed in the same manner as the future potential for without project conditions. Average annual damages are expected to be $2,361,900. Flood damage susceptibility for the Plan 1 and Plan 1A condition in the year 2006 is shown in table 23. The future annual increase in flood damages is amortized and discounted at 8%, 6%, and 2 1/2% to calculate the average annual equivalent of these flood damages. The result of this analysis is average annual equivalent flood damages for the Plan 1 and Plan 1A condition. Average annual equivalent damages are estimated to be $2,354,600 at 8%, $2,356,100 at 6%, and $2,358,400 at 2 1/2%.

Existing and Future Damage Potential, Plan 2 - Plan 2 is evaluated with the west 1/2 of the Frog Pond removed. Average annual damage for the 2001 condition is estimated to be $ 2,242,000. Average annual damage for the 2006 condition is estimated to be $2,293,500. Average annual equivalent damages for Plan 2 is estimated to be $2,286,300 at 8%, $2,287,700 at 6%, and $2,290,000 at

2 1/2%. Flood damage susceptibility for the 2001 and 2006-2051 conditions are shown in table 24 and table 25.

Existing and Future Damage Potential, Plans 3, 4, 5, 6, 6A - Plans 3, 4, 5, 6, and 6A are evaluated with the entire Frog Pond removed. Average annual damage for the 2001 condition is estimated to be $ 1,984,800. Average annual damage for the 2006 condition is estimated to be $ 2,071,000. Average annual equivalent damages for Plans 3, 4, 5 and 6 are estimated to be $2,058,900 at 8%, $2,061,200 at 6%, and $2,065,200 at 2 1/2%. Average annual flood damages for the 2001 and 2006-2051 conditions are shown in table 26 and table 27.

Benefit Evaluation. Average annual equivalent flood reduction benefits are measured as the difference between without and with project average annual equivalent flood damages. Since hydrologic response is expected to be approximately the same for all plans, the only difference among benefits is due to the reduction of benefits from reduced production in the basin with the purchase of frog pond land. Average annual flood damage summaries with and without project for the years 2001 and 2006 are shown in tables 28 and 29. Average annual equivalent flood reduction benefits for each plan calculated at an 8 % interest rate are shown in table 30.

Maximization of Net Benefits - It is required in the "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies", March, 1983, that various alternative plans are to be formulated in a systematic manner to ensure that all reasonable alternatives are evaluated. Another requirement is that a plan that reasonably maximizes net national economic development benefits should be formulated. The formulation of this alternative requires an analysis to determine what degree of flood control protection will maximize net flood control benefits. Net flood control benefit functions are analyzed by plotting average annual equivalent inundation reduction benefits less the average annual equivalent costs, for an array of plans. The resulting functions are measures of economic efficiency and the respective maximums identify the degree of protection at which net benefits are maximized.

As discussed previously, each of the alternatives provide similar hydrologic and hydraulic responses and significantly reduce damage potential from the 10 year flood event. Slight changes in flood damage effects are noted since some of the plans require different quantities of land purchases in the Frog Pond area located in the south-west portion of the economic study area. Since the annual value of the procurement cost of these lands is larger than the reduced damage susceptibility achieved by removing their productive potential, incremental net benefits will decrease for those alternatives which purchase the Frog Pond.

The design of this segment which is part of the original C&SF project provided for containment of 40% of SPF flow and 10 year agricultural protection. Since initial project construction in the 1960's, damage susceptibility has increased due to the increased value of crops and agricultural encroachment which has taken place in the floodplain. Alternatives have been designed to approximately re-instate the original project protection. Designs larger than 10 year design would greatly escalate construction costs for channel excavation and pump costs for flood control due to the severely restricted outlet capacity caused by the lack of sufficient head differentials at the structures. Additional flood damage reduction might be achieved, but at a very large cost. Smaller designs would not meet the intent of restoring protection originally designed under the original authorization.

All plans provide approximately the same net flood protection benefits. Therefore, the plan selection process becomes totally a function of environmental efficiency. The benefit-to-cost ratio for the flood control portion of all alternatives based upon benefits and costs of alternative 1A is approximately 1.05-to-1 at an 8 percent interest rate. Project costs and benefits are shown for the eight alternatives at an 8 percent interest rate are shown in table 31. Net benefits for the eight alternatives at a 6 percent interest rate and a 2 1/2 percent interest rate are shown in tables 32 and 33.

C-111
GENERAL REEVALUATION REPORT
Appendix E
Social and Economic Analysis

TABLES

Table 1
C-111 Study Area, 1986 Land Use

Type of Use	Acres	% of Agricultural Land	% of Total
Row and Field Crops	23,117	62.9%	54.1%
Fruit and Tree Crops	12,558	34.1%	29.4%
Nurseries	1,093	3.0%	2.6%
Sub-Total	36,768	100.0%	86.1%
Wetlands and Other Open Land	4,157		9.7%
Urban Land	1,783		4.2%
Total Acres	42,708		100.0%
Total Damage[1] Susceptible Acreage	36,772		86.1%

[1] Productive acreages are reduced by 10% to allow for infrastructure. Infrastructure includes roads, right of ways for electrical lines, drainage ditches, etc. Productive acreages are again reduced by approximately 4% to account for the average percentage of agricultural land that lies fallow within a given productive operation.

Table 2
C-111 Study Area, 2001 Land Use

Land Use	Estimated Acreage	Sub-total
Tomatoes	9,921.08[2]	
Potatoes	804.19	
Squash	2,306.02	
Snap Beans	3,390.86	
Pole Beans	41.65	
Cabbage	35.84	
Corn	2,447.07	
Lettuce	246.02	
Peppers	84.59	
Sweet Potatoes	173.51	
Malanga	410.84	
Calabanza	491.16	
Okra	315.25	
Yuca	398.18	
Mixed Vegetables	3,639.43[3]	
Cucumbers	74.25	
General Agriculture	532.50	25,312.44
Limes	1,565.91	
Mangos	582.74	
Avocados	3,697.10	
Maturing Limes	1,842.09	
Maturing Mangos	194.25	
Maturing Avocados	943.05	8,825.14
Papaya	309.16	
Bananas	42.66	
Guava	185.65	
Lychee	46.21	583.68
Sunflower	57.55	
Nursery	1,035.40	
Wetland and Other Open Land	4,018.18	5,111.13
Urban	2,199.96[4]	2,199.96
Total Acres		42,032.35
Adjusted Acreage [5]		36,749.41

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[2] Excludes tomato acreage in the Frog Pond at or below 4.25ft msl. The evaluation assumes the without and with project conditions will be operated at authorized stages. This acreage is included under wetland and other open acreage.

[3] 50% of the downed fruit tree acreage will not be replanted. This acreage will remain in mixed vegetables.

[4] Urban land use acreage is primarily single family residential and mobile homes. Some airport and recreational acreage is included in this value.

[5] Productive acreages are reduced by 10% to allow for infrastructure. Infrastructure includes roads, right of ways for electrical lines, drainage ditches, etc. Productive acreages are again reduced by approximately 4% to account for the average percentage of agricultural land that lies fallow within a given productive operation.

Table 3
Agricultural Land Use Classifications, Root Depths and Bedding Heights

	Land Use Class	Decreased Topographic Adjustment (Feet)	Root Depth (Feet)	Bedding Height (Feet)
Tomatoes	1	0.17	0.67	0.50
Potatoes	2	0.17	0.67	0.50
Squash	3	0.17	0.67	0.50
Snap Beans	4	0.17	0.67	0.50
Cabbage	5	0.17	0.67	0.50
Corn	6	0.17	0.67	0.50
Lettuce	7	0.17	0.67	0.50
Peppers	8	0.17	0.67	0.50
Okra	9	0.17	0.67	0.50
Mixed Vegetables	10	0.17	0.67	0.50
Cucumbers	11	0.17	0.67	0.50
Sweet Potatoes	12	0.17	0.67	0.50
Malanga	13	0.17	0.67	0.50
Calabanza	14	0.17	0.67	0.50
Yuca	15	0.17	0.67	0.50
Pole Beans	16	0.17	0.67	0.50
Limes	17	0.08	1.50	1.42
Mangos	18	0.08	1.50	1.42
Avocados	19	0.08	1.50	1.42
Papaya	20	-0.42	1.00	1.42
Bananas	21	-0.17	1.25	1.42
Guava	22	-0.67	0.75	1.42
Lychee	23	-0.17	1.25	1.42
Nursery	24	0.28[6]	2.00	1.42

[6] The actual computed root zone depth of 0.58 feet is reduced to 0.28 feet below ground to compensate for horticulture plants which are in containers with roots at ground level. The actual composite root length was computed by weighting foliage nursery plants, woody ornamental plants and field nursery plant root zones by the percentages of productive acreage for each crop.

Table 4
Root Zone Depths
Citrus and Selected Fruit Crops

Crop	Minimum	Maximum	Used in Study
Limes	N/A	N/A	18 inches
Mangos	N/A	N/A	18 inches
Avocados	N/A	N/A	18 inches
Papaya	N/A	N/A	12 inches
Bananas	12 inches	18 inches	15 inches
Guava	6 inches	12 inches	9 inches
Lychee	12 inches	18 inches	15 inches

Table 5
Vegetable Crop Loss Per Acre [7]

Crop	Inundation Period To Plant Mortality	Loss Per Acre [8]
Tomatoes	12 Hrs.	3,872
Potatoes	24 Hrs.	1,656
Squash	12 Hrs.	1,289
Snap Beans	12 Hrs.	1,241
Pole Beans	12 Hrs.	1,550
Cabbage	12 Hrs.	1,130
Corn	12 Hrs.	1,402
Leaf Crops	12 Hrs.	1,913
Peppers	12 Hrs.	4,537
Sweet Potatoes	24 Hrs.	900
Malanga	12 Hrs.	1,300
Calabaza	12 Hrs.	625
Okra	12 Hrs.	1,265
Yuca	12 Hrs.	900
Mixed Vegetables	12 Hrs.	1,311
Cucumbers	12 Hrs.	1,940

[7] Information provided by the Institute of Food and Agricultural Sciences (IFAS), University of Florida, Gainesville and the Dade County Extension Service, Homestead, Florida.

[8] Includes pre-harvest operating costs and fixed costs (rent, depreciation, licenses, and insurance). Per acre loss includes all costs incurred by grower up to harvest period.

Table 6
Fruit Crop Loss Per Acre[9]

	Fruit Loss Per Acre	Age Of Mature Replacement Tree	Fruit and Tree Loss Per Acre[10]
Limes	$2,050	6 Years	$11,050
Mangoes	$3,200	7 Years	13,700
Avocados	$2,050	8 Years	14,050
Papaya	$2,500	1 Year	4,000
Carambola	$2,950	3 Years	7,450
Banana[11]	-	-	-
Guava	-	-	-
Lychee	-	-	-

[9] Information provided by the Dade County Extension Service and the University of Florida Tropical Research Station. Homestead, Florida.

[10] Tree loss includes operating and fixed costs during the tree maturity period.

[11] Bananas, guava, and lychee are highly water tolerant. No data is available on water-resistance periods and no known damages have occurred in previous flooding situations.

Table 7
Tolerance Periods for Fruit Crops [12]

1. Limes
   a. Fruit losses will begin after 2 days with 100% loss in 2 weeks.
   b. Tree losses will begin after 7 days with 100% loss in 2 weeks.

2. Avocados
   a. Fruit losses will occur from the beginning of the flood and continue to 100% loss in 8 to 12 hours. Maximum loss will occur at 10 hours in this analysis.
   b. Tree losses will occur from the beginning of the flood with 100% loss in 24 hours.

3. Mangos are somewhat flood tolerant but very disease susceptible.
   a. Fruit losses will occur from the beginning of the flood with 100% loss in 10 days.
   b. Tree losses will begin after 10 days with 100% loss in 6 weeks.

4. Papaya is very damage susceptible.
   a. Fruit losses will occur from the beginning of the flood with 100% loss in 6 hours.
   b. Tree losses will occur from the beginning of the flood with 100% loss in 12 hours.

5. Carambola
   a. Fruit losses will occur from the beginning of the flood with 100% loss in 18 hours.
   b. Tree losses will begin after 7 days with 100% loss in 3 weeks.

6. Lychee are somewhat water tolerant but not highly water tolerant.
   a. Fruit losses will occur from the beginning of the flood with 100% loss in 10 days.
   b. Tree losses will begin after 10 days with 100% loss in 6 weeks.

7. No information is available for Bananas. Bananas are highly water tolerant and no damage was recorded to bananas in the 1981 flood. Therefore, damage susceptibility of bananas are not considered in the study.

8. No information is available for Guava. Guava is highly water tolerant and no damage was recorded to guava in the 1981 flood. Therefore, damage susceptibility of guava is not considered in the study.

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[12] Source: Dade County Extension Service (IFAS), Homestead, Florida.

Table 8
Horticultural Plants Grown in the C-111 Basin

Foliage Nurseries	Field Nurseries
Agleonema species	Acacia species
Aralia species	Bauhinia species
Brassia species	Brassia actinophylla
Chamaedorea species	Bucida species
Codieum variegatm	Callistemon viminalis
Chrysalidocarpus lutescens	Callophyllum antillanum
Dieffenbachia species	Cocoloba uvifera
Dracaena species	Conocarpus erectus
Ficus benjamina	Dalbergia sissoo
Ficus "Broad Leaf Species"	Ligustrum
Phoenix roebellinii	Palms
Philodendron seloum	Podocarpus species
Pleomele reflexa	Quercus virginiana
	Swietenia mahogani
	Tabebuia species

Woody Ornamental Nurseries

Asparagus springerii	Ixora coccinea "species"
Bougainvillea species	Jasmine species
Brassia species	Ligustrum species
Carissa macrocarpa	Liriope species
Chamaedorea species	Nerium oleander
Chrysalidocarpus lutescens	Philodendron selloum
Chrysobalanus icaco	Phoenix roebellinii
Crinum asiaticum	Pilea macrocarpa
Euphorbia millii	Pittosporum species
Eugenia uniflora	Podocarpus species
Ficus benjamina	Viburnum species
Hibiscus species	

Table 9
Horticulture Loss Calculations

	Total Value Crops 83-84	Productive Acreage in 83-84	Productive Acreage in 1986	Value per Acre in 1986	Production Costs per acre [13]	Maximum Production Losses per acre
Foliage Nurseries	$66,000,000	2,000	2,400	$33,000	$29,601	$20,720 [14]
Woody Ornamentals	$18,000,000	667	800	$27,000	$24,165	$20,540 [15]
Field Nurseries	$42,000,000	2,000	3,000	$21,000	$17,178	$17,178

[13] Production costs per acre are estimated using percentages computed from tables 2 and 3 in the publication, "Business Analysis of Ornamental Plant Nurseries in Florida, 1990", Economic Information Report EI 92-1r, IFAS, University of Florida, May 1992.

[14] Reduced by 30% as described in text.

[15] Reduced by 15% as discussed in text.

Table 10
Horticulture Damage Relationship

Time (Days)	Foliage Nurseries	Adjusted[16] Foliage Nurseries	Woody Ornamental	Adjusted[17] Woody Ornamentals	Field Nurseries	Average[18]
	Damage per Acre					
1.0	11,092.00	$7,764.40	14,937.16	$12,696.59	63.63	4,674.63
2.0	29,601.00	$20,720.70	17,426.87	$14,812.84	423.05	10,136.95
3.0	29,601.00	$20,720.70	21,749.00	$18,486.65	1,426.34	11,096.45
4.0	29,601.00	$20,720.70	21,749.00	$18,486.65	3,151.24	11,931.08
5.0	29,601.00	$20,720.70	21,749.00	$18,486.65	4,935.38	12,794.38
6.0	29,601.00	$20,720.70	21,749.00	$18,486.65	6,303.51	13,456.38
7.0	29,601.00	$20,720.70	21,749.00	$18,486.65	7,354.94	13,965.13
8.0	29,601.00	$20,720.70	21,749.00	$18,486.65	8,253.49	14,399.91
9.0	29,601.00	$20,720.70	21,749.00	$18,486.65	9,133.96	14,825.95
10.0	29,601.00	$20,720.70	21,749.00	$18,486.65	10,096.71	15,291.80
11.0	29,601.00	$20,720.70	21,749.00	$18,486.65	11,223.31	15,836.92
12.0	29,601.00	$20,720.70	21,749.00	$18,486.65	12,521.89	16,465.27
13.0	29,601.00	$20,720.70	21,749.00	$18,486.65	13,948.44	17,155.54
14.0	29,601.00	$20,720.70	21,749.00[19]	$18,486.65	15,460.00[20]	17,886.94

[16] Assumed 30% of foliage nurseries are protected at the time of the flood.

[17] Assumes 15% of Woody Ornamentals are protected at the time of the flood.

[18] Average is weighted by the percentage of total productive acreage for each classification.

[19] Maximum duration-damage estimate is based upon 90% of production costs per acre shown in table 9.

[20] Maximum duration-damage estimate is based upon 90% of production costs per acre shown in table 9.

Table 11
Dade County (1991-1992 Prices)
Field Crop Production Costs
Crop: Tomatoes

	Average per acre	%	Loss/acre after land preparation	%	Loss/acre at end of growth pd	%	Loss/acre at end of harvest
Operating Costs:							
Seed	$201.70	100%	$201.70	100%	$201.70	0%	$0.00
Fertilizer	$339.50	33%	$112.04	100%	$339.50	0%	$0.00
Spray and Dust	$810.73	0%	$0.00	100%	$810.73	0%	$0.00
Labor	$694.23	33%	$229.10	100%	$694.23	0%	$0.00
Machinery	$235.97	25%	$58.99	100%	$235.97	0%	$0.00
Interest	$187.25	0%	$0.00	100%	$187.25	0%	$0.00
Miscellaneous							
Custom Equipment	$412.50	100%	$412.50	100%	$412.50	0%	$0.00
Custom Work							
Stake Depreciation and Maint.	$128.00	0%	$0.00	100%	$128.00	0%	$0.00
Plastic Disposal	$75.00	0%	$0.00	100%	$75.00	0%	$0.00
Tie Plants	$130.68	100%	$130.68	100%	$130.68	0%	$0.00
Scouting	$35.00	0%	$0.00	100%	$35.00	0%	$0.00
Well Maintenance	$15.00	0%	$0.00	100%	$15.00	0%	$0.00
Farm Vehicles	$20.83	33%	$6.87	100%	$20.83	0%	$0.00
Frost Protection	$100.00	0%	$0.00	100%	$100.00	0%	$0.00
Sub-totals:			$1,151.88		$3,386.39	0%	$0.00
Fixed Costs:							
Rent	$200.00	0%	$0.00	100%	$200.00	0%	$0.00
Machinery Depreciation	$125.66	0%	$0.00	100%	$125.66	0%	$0.00
Overhead	$384.52	33%	$126.89	100%	$384.52	0%	$0.00
Sub-totals:	$710.18		$126.89		$710.18		$0.00
Total:		31.22%	$1,278.77		$4,096.57		$0.00

Table 12
Daily Production Cost Expenditures[21]

Date	Early[22] Planters First (1/3) Preparation	Early[23] Planters First(1/3) Growth	Early[24] Planters First(1/3) Harvest	Early Planters Second(1/3) Preparation	Early Planters Second(1/3) Growth	Early Planters Second(1/3) Harvest	Early Planters Last(1/3) Preparation	Early Planters Last(1/3) Growth	Early Planters Last (1/3) Harvest
01-Aug-93									
02-Aug-93									
03-Aug-93									
04-Aug-93									
05-Aug-93									
06-Aug-93									
07-Aug-93									
08-Aug-93									
09-Aug-93									
10-Aug-93									
11-Aug-93									
12-Aug-93									
13-Aug-93									

[21] This information is an example using only the early season planters.

[22] Land preparation costs are computed using the following equation: (1/3 * 1/3 * 31% * D_n/14). The equation represents 1/3 of the planters planting the first third of their acreage. Acreage production costs are estimated at 31% of the total. At the D_{14}th day, the last factor becomes 1 indicating all land preparation costs for these crops are in the ground.

[23] The growth period is handled similarly to the land preparation period using the following equation. (1/3 * 1/3 * 69% * D_n/ 70) This equation represents 1/3 of the planters planting the first third of their acreage. Costs incurred during the growing period are estimated to be 69% of the total. At the D_{70}th day, the last factor becomes 1 indicating all growing costs have been expended and the crop is ready for harvest.

[24] During the harvest, the crop is removed from the ground and production costs are re-claimed. Therefore, losses that would result with a flood during this period decrease during the harvest period. Production costs claimable during the harvest period are computed using the following equation where total cost is the sum of land preparation costs and growing period costs: (Total Cost - (Total Cost * D_n/14)). At the D_{14}th day, the last factor becomes 1 and the expression becomes 0 indicating all production costs have been re-claimed.

Table 12 (Continued)
Daily Production Cost Expenditures

Date	Early Planters First (1/3) Preparation	Early Planters First(1/3) Growth	Early Planters First(1/3) Harvest	Early Planters Second(1/3) Preparation	Early Planters Second(1/3) Growth	Early Planters Second(1/3) Harvest	Early Planters Last(1/3) Preparation	Early Planters Last(1/3) Growth	Early Planters Last (1/3) Harvest
14-Aug-93									
15-Aug-93									
16-Aug-93									
17-Aug-93									
18-Aug-93	0.246%								
19-Aug-93	0.492%								
20-Aug-93	0.738%								
21-Aug-93	0.984%								
22-Aug-93	1.230%								
23-Aug-93	1.476%								
24-Aug-93	1.722%								
25-Aug-93	1.968%								
26-Aug-93	2.214%								
27-Aug-93	2.460%								
28-Aug-93	2.706%			0.246%					
29-Aug-93	2.952%			0.492%					
30-Aug-93	3.198%			0.738%					
31-Aug-93	3.444%			0.984%					
01-Sep-93	3.444%	0.110%		1.230%					
02-Sep-93	3.444%	0.219%		1.476%					
03-Sep-93	3.444%	0.329%		1.722%					
04-Sep-93	3.444%	0.438%		1.968%					
05-Sep-93	3.444%	0.548%		2.214%					
06-Sep-93	3.444%	0.657%		2.460%					
07-Sep-93	3.444%	0.767%		2.706%			0.246%		
08-Sep-93	3.444%	0.876%		2.952%			0.492%		

Table 12 (Continued)
Daily Production Cost Expenditures

Date	Early Planters First (1/3) Preparation	Early Planters First(1/3) Growth	Early Planters First(1/3) Harvest	Early Planters Second(1/3) Preparation	Early Planters Second(1/3) Growth	Early Planters Second(1/3) Harvest	Early Planters Last(1/3) Preparation	Early Planters Last(1/3) Growth	Early Planters Last (1/3) Harvest
09-Sep-93	3.444%	0.986%		3.198%			0.738%		
10-Sep-93	3.444%	1.095%		3.444%			0.984%		
11-Sep-93	3.444%	1.205%		3.444%	0.110%		1.230%		
12-Sep-93	3.444%	1.314%		3.444%	0.219%		1.476%		
13-Sep-93	3.444%	1.424%		3.444%	0.329%		1.722%		
14-Sep-93	3.444%	1.533%		3.444%	0.438%		1.968%		
15-Sep-93	3.444%	1.643%		3.444%	0.548%		2.214%		
16-Sep-93	3.444%	1.752%		3.444%	0.657%		2.460%		
17-Sep-93	3.444%	1.862%		3.444%	0.767%		2.706%		
18-Sep-93	3.444%	1.971%		3.444%	0.876%		2.952%		
19-Sep-93	3.444%	2.081%		3.444%	0.986%		3.198%		
20-Sep-93	3.444%	2.190%		3.444%	1.095%		3.444%		
21-Sep-93	3.444%	2.300%		3.444%	1.205%		3.444%	0.110%	
22-Sep-93	3.444%	2.410%		3.444%	1.314%		3.444%	0.219%	
23-Sep-93	3.444%	2.519%		3.444%	1.424%		3.444%	0.329%	
24-Sep-93	3.444%	2.629%		3.444%	1.533%		3.444%	0.438%	
25-Sep-93	3.444%	2.738%		3.444%	1.643%		3.444%	0.548%	
26-Sep-93	3.444%	2.848%		3.444%	1.752%		3.444%	0.657%	
27-Sep-93	3.444%	2.957%		3.444%	1.862%		3.444%	0.767%	
28-Sep-93	3.444%	3.067%		3.444%	1.971%		3.444%	0.876%	
29-Sep-93	3.444%	3.176%		3.444%	2.081%		3.444%	0.986%	
30-Sep-93	3.444%	3.286%		3.444%	2.190%		3.444%	1.095%	
01-Oct-93	3.444%	3.395%		3.444%	2.300%		3.444%	1.205%	
02-Oct-93	3.444%	3.505%		3.444%	2.410%		3.444%	1.314%	
03-Oct-93	3.444%	3.614%		3.444%	2.519%		3.444%	1.424%	
04-Oct-93	3.444%	3.724%		3.444%	2.629%		3.444%	1.533%	
05-Oct-93	3.444%	3.833%		3.444%	2.738%		3.444%	1.643%	
06-Oct-93	3.444%	3.943%		3.444%	2.848%		3.444%	1.752%	
07-Oct-93	3.444%	4.052%		3.444%	2.957%		3.444%	1.862%	

Table 12 (Continued)
Daily Production Cost Expenditures

Date	Early Planters First (1/3) Preparation	Early Planters First(1/3) Growth	Early Planters First(1/3) Harvest	Early Planters Second(1/3) Preparation	Early Planters Second(1/3) Growth	Early Planters Second(1/3) Harvest	Early Planters Last(1/3) Preparation	Early Planters Last(1/3) Growth	Early Planters Last (1/3) Harvest
08-Oct-93	3.444%	4.162%		3.444%	3.067%		3.444%	1.971%	
09-Oct-93	3.444%	4.271%		3.444%	3.176%		3.444%	2.081%	
10-Oct-93	3.444%	4.381%		3.444%	3.286%		3.444%	2.190%	
11-Oct-93	3.444%	4.490%		3.444%	3.395%		3.444%	2.300%	
12-Oct-93	3.444%	4.600%		3.444%	3.505%		3.444%	2.410%	
13-Oct-93	3.444%	4.710%		3.444%	3.614%		3.444%	2.519%	
14-Oct-93	3.444%	4.819%		3.444%	3.724%		3.444%	2.629%	
15-Oct-93	3.444%	4.929%		3.444%	3.833%		3.444%	2.738%	
16-Oct-93	3.444%	5.038%		3.444%	3.943%		3.444%	2.848%	
17-Oct-93	3.444%	5.148%		3.444%	4.052%		3.444%	2.957%	
18-Oct-93	3.444%	5.257%		3.444%	4.162%		3.444%	3.067%	
19-Oct-93	3.444%	5.367%		3.444%	4.271%		3.444%	3.176%	
20-Oct-93	3.444%	5.476%		3.444%	4.381%		3.444%	3.286%	
21-Oct-93	3.444%	5.586%		3.444%	4.490%		3.444%	3.395%	
22-Oct-93	3.444%	5.695%		3.444%	4.600%		3.444%	3.505%	
23-Oct-93	3.444%	5.805%		3.444%	4.710%		3.444%	3.614%	
24-Oct-93	3.444%	5.914%		3.444%	4.819%		3.444%	3.724%	
25-Oct-93	3.444%	6.024%		3.444%	4.929%		3.444%	3.833%	
26-Oct-93	3.444%	6.133%		3.444%	5.038%		3.444%	3.943%	
27-Oct-93	3.444%	6.243%		3.444%	5.148%		3.444%	4.052%	
28-Oct-93	3.444%	6.352%		3.444%	5.257%		3.444%	4.162%	
29-Oct-93	3.444%	6.462%		3.444%	5.367%		3.444%	4.271%	
30-Oct-93	3.444%	6.571%		3.444%	5.476%		3.444%	4.381%	
31-Oct-93	3.444%	6.681%		3.444%	5.586%		3.444%	4.490%	
01-Nov-93	3.444%	6.790%		3.444%	5.695%		3.444%	4.600%	
02-Nov-93	3.444%	6.900%		3.444%	5.805%		3.444%	4.710%	
03-Nov-93	3.444%	7.010%		3.444%	5.914%		3.444%	4.819%	
04-Nov-93	3.444%	7.119%		3.444%	6.024%		3.444%	4.929%	

Table 12 (Continued)
Daily Production Cost Expenditures

Date	Early Planters First (1/3) Preparation	Early Planters First(1/3) Growth	Early Planters First(1/3) Harvest	Early Planters Second(1/3) Preparation	Early Planters Second(1/3) Growth	Early Planters Second(1/3) Harvest	Early Planters Last(1/3) Preparation	Early Planters Last(1/3) Growth	Early Planters Last (1/3) Harvest
05-Nov-93	3.444%	7.229%		3.444%	6.133%		3.444%	5.038%	
06-Nov-93	3.444%	7.338%		3.444%	6.243%		3.444%	5.148%	
07-Nov-93	3.444%	7.448%		3.444%	6.352%		3.444%	5.257%	
08-Nov-93	3.444%	7.557%		3.444%	6.462%		3.444%	5.367%	
09-Nov-93	3.444%	7.667%		3.444%	6.571%		3.444%	5.476%	
10-Nov-93	0.000%	0.000%	10.317%	3.444%	6.681%		3.444%	5.586%	
11-Nov-93			9.524%	3.444%	6.790%		3.444%	5.695%	
12-Nov-93			8.730%	3.444%	6.900%		3.444%	5.805%	
13-Nov-93			7.937%	3.444%	7.010%		3.444%	5.914%	
14-Nov-93			7.143%	3.444%	7.119%		3.444%	6.024%	
15-Nov-93			6.349%	3.444%	7.229%		3.444%	6.133%	
16-Nov-93			5.556%	3.444%	7.338%		3.444%	6.243%	
17-Nov-93			4.762%	3.444%	7.448%		3.444%	6.352%	
18-Nov-93			3.968%	3.444%	7.557%		3.444%	6.462%	
19-Nov-93			3.175%	3.444%	7.667%		3.444%	6.571%	
20-Nov-93			2.381%	0.000%	0.000%	10.317%	3.444%	6.681%	
21-Nov-93			1.587%			9.524%	3.444%	6.790%	
22-Nov-93			0.794%			8.730%	3.444%	6.900%	
23-Nov-93			0.000%			7.937%	3.444%	7.010%	

Table 13
Seasonal Adjustments for Field Crops

Month	Monthly Probabilities of Flooding	Cumulative Percentages Production Costs
January	0.00%	30.95%
February	2.00%	20.93%
March	3.00%	26.70%
April	5.00%	7.04%
May	11.00%	0.00%
June	20.00%	0.00%
July	2.00%	0.00%
August	12.00%	0.09%
September	23.00%	11.19%
October	20.00%	23.23%
November	2.00%	35.56%
December	0.00%	24.73%

Table 14
Floodprone Area Summary[25]
By Frequency and Land Use Classification
No Frog Pond Purchases
Without Project (in acres)

Land Use	SPF	100 Year	50 Year	25 Year	10 Year	2 Year
Tomatoes	7,800	5,893	5,131	4,127	2,447	1,530
Potatoes	692	674	598	514	132	60
Squash	1,698	1,261	925	811	241	134
Snap Beans	2,659	2,299	1,840	1,380	462	41
Pole Beans	36	31	31	29	16	0
Cabbage	31	31	31	31	0	0
Corn	1,842	1,325	1,232	869	233	164
Lettuce	212	212	212	212	0	0
Peppers	73	73	62	37	0	0
Sweet Potatoes	149	98	70	58	0	0
Malanga	354	354	354	327	194	23
Calabanza	423	423	382	358	144	0
Okra	271	220	174	139	11	0
Yuca	343	335	264	199	0	0
Mixed Vegetables	2,835	2,091	1,553	965	175	0
Cucumbers	64	64	64	0	0	0
Limes	1,202	865	575	367	55	0
Mangos	479	357	300	220	23	0
Avocados	2,790	1,952	1,551	1,013	84	0
Papaya	261	211	158	52	28	0
Bananas	37	17	14	0	0	0
Guava	143	80	0	0	0	0
Lychee	40	30	0	0	0	0
Nursery	883	844	740	715	257	78
General Agriculture	337	337	337	144	0	0
Fallow	3,857	3,423	3,386	3,307	2,992	2,499
Maturing Limes	1,402	1,009	671	429	64	0
Maturing Mangos	160	119	100	73	8	0
Maturing Avocados	721	503	400	261	22	0
Sum:	31,794	25,129	21,154	16,638	7,585	4,528

[25] Acreage in table 14 is cataloged as floodprone when flood elevations are above ground level. Affected field crop acreage may be less than shown depending upon the growing season of the crop and the seasonal occurrence of the flood.

Table 15
Floodprone Area Summary[26]
By Frequency and Land Use Classification
No Frog Pond Purchases
With Project (in acres)

Land Use	SPF	100 Year	50 Year	25 Year	10 Year	2 Year
Tomatoes	6,559	4,320	4,045	3,291	1,985	662
Potatoes	653	586	546	385	61	8
Squash	1,211	1,030	841	645	189	61
Snap Beans	2,306	1,825	1,579	958	149	0
Pole Beans	20	15	15	13	0	0
Cabbage	31	31	31	31	0	0
Corn	1,466	1,012	916	623	34	24
Lettuce	212	212	212	212	0	0
Peppers	73	73	62	37	0	0
Sweet Potatoes	149	98	58	58	0	0
Malanga	342	342	342	304	122	50
Calabanza	406	385	364	279	96	0
Okra	239	176	146	109	0	0
Yuca	343	314	249	168	0	0
Mixed Vegetables	2,496	1,952	1,483	835	50	0
Cucumbers	64	3	3	0	0	0
Limes	1,034	764	501	321	26	0
Mangos	407	352	294	209	23	0
Avocados	2,273	1,795	1,391	814	0	0
Papaya	257	165	59	52	28	0
Bananas	28	14	0	0	0	0
Guava	143	71	0	0	0	0
Lychee	30	30	0	0	0	0
Nursery	663	575	489	331	0	0
General Agriculture	337	337	337	57	0	0
Fallow	3,275	2,841	2,622	2,309	1,758	838
Maturing Limes	1,206	891	585	374	30	0
Maturing Mangos	136	117	98	70	8	0
Maturing Avocados	588	462	358	210	0	0
Sum:	26,946	20,790	17,626	12,693	4,559	1,642

[26] Acreage in table 15 is cataloged as floodprone when flood elevations are above ground level. Affected field crop acreage may be less than shown depending upon the growing season of the crop and the seasonal occurrence of the flood.

Table 16
Damage Potential
Fruit Crops, Nurseries, and Urban
Without Project Condition
2001 Land Use Condition

Land Use	SPF	100yr	50yr	25yr	10yr	2yr
Limes	1,358,110.68	455,481.23	165,943.62	90,978.51	8,616.20	0.00
Mangos	859,013.15	475,902.29	329,776.40	182,146.35	29,694.39	0.00
Avocados	39,049,197.52	26,769,496.82	21,186,817.79	13,861,270.23	1,144,531.88	0.00
Papaya	1,044,360.00	842,759.99	580,525.61	208,280.00	110,040.00	0.00
Maturing Limes	542,644.23	143,890.58	84.05	2,802.15	0.00	0.00
Maturing Mangos	3,992.48	2,234.15	0.00	0.00	0.00	0.00
Maturing Avocadoes	8,622,269.47	5,873,035.69	4,642,278.50	3,039,740.89	250,790.72	0.00
Total Fruit Crops	51,479,587.53	34,562,800.75	26,905,425.97	17,385,218.13	1,543,673.19	0.00
Nursery	13,045,577.23	11,478,483.46	10,185,369.18	8,447,332.30	4,346,550.24	1,335,911.63
Urban	24,669,774.83	11,904,773.08	8,872,090.28	6,749,192.23	1,067,743.08	298,220.91

Table 17
Full Production Damage Potential
Vegetable Crops
Without Project Condition
2001 Land Use Condition
No Frog Pond Land Purchases

Land Use	SPF	100yr	50yr	25yr	10yr	2yr
Tomatoes	29,947,247.74	22,821,435.15	19,866,200.21	15,894,519.95	9,413,990.93	5,924,993.77
Potatoes	1,146,708.36	1,112,398.25	975,554.35	850,757.44	211,358.88	98,815.91
Squash	2,187,435.86	1,614,077.98	1,193,498.19	1,046,545.58	310,441.09	166,486.70
Snap Beans	3,298,292.82	2,802,095.09	2,283,654.78	1,713,339.92	525,805.14	51,108.91
Pole Beans	55,583.00	48,174.00	48,174.00	44,516.00	24,443.50	0.00
Cabbage	34,890.01	34,890.01	34,890.01	34,890.01	0.00	0.00
Corn	2,583,045.26	1,857,709.30	1,715,541.33	1,218,994.64	310,085.83	230,050.59
Lettuce	405,353.60	405,353.60	405,353.60	405,353.60	0.00	0.00
Peppers	330,427.29	330,427.29	280,196.17	167,845.45	0.00	0.00
Sweet Potatoes	134,451.00	88,488.00	55,764.87	52,407.00	0.00	0.00
Malanga	459,849.00	459,849.00	459,849.00	424,671.00	248,604.75	29,887.00
Calabanza	264,306.25	264,306.25	238,593.75	223,481.25	88,227.77	0.00
Okra	343,489.23	278,557.45	219,611.39	176,053.57	13,312.85	0.00
Yuca	308,556.00	301,599.00	233,423.45	178,992.00	0.00	0.00
Mixed Vegetables	3,717,215.36	2,733,721.14	2,031,027.27	1,265,424.70	201,720.36	0.00
Cucumbers	124,055.54	124,055.54	124,055.54	0.00	0.00	0.00
General Agriculture	441,811.10	441,811.10	441,811.10	189,190.28	0.00	0.00
Field Crops	45,782,717.42	35,718,948.15	30,607,199.01	23,886,982.39	11,347,991.10	6,501,342.88

Table 18
Expected Damage Potential
Without Project Conditions
2001 Land Use Condition
No Frog Pond Land Purchases

Full Production Field Crop Flood Damage			SPF 45,782,717.42	100yr 35,718,948.15	50yr 30,607,199.01	25yr 23,886,982.39	10yr 11,347,991.10	2yr 6,501,342.88
Date or Growing Season (Mid-month)	% chance occurrence	Average Basin wide % of total production costs	SPF Adjusted Frequency Damage	100yr Adjusted Frequency Damage	50yr Adjusted Frequency Damage	25yr Adjusted Frequency Damage	10yr Adjusted Frequency Damage	2yr Adjusted Frequency Damage
January	0.00%	30.95%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
February	2.00%	20.93%	$191,628.14	$149,505.23	$128,109.49	$99,981.35	$47,498.15	$27,212.02
March	3.00%	26.70%	$366,747.04	$286,130.21	$245,182.03	$191,349.06	$90,904.22	$52,079.66
April	5.00%	7.04%	$161,178.06	$125,748.56	$107,752.64	$84,094.12	$39,950.60	$22,887.98
May	11.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
June	20.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
July	2.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
August	12.00%	0.09%	$5,015.95	$3,913.37	$3,353.32	$2,617.06	$1,243.29	$712.29
September	23.00%	11.19%	$1,178,731.00	$919,627.18	$788,019.07	$614,999.03	$292,167.65	$167,384.87
October	20.00%	23.23%	$2,126,973.49	$1,659,430.89	$1,421,949.25	$1,109,741.43	$527,204.97	$302,039.39
November	2.00%	35.56%	$325,625.00	$254,047.45	$217,690.64	$169,893.77	$80,711.45	$46,240.15
December	0.00%	24.73%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Field Crops	100.00%		$4,355,898.67	$3,398,402.88	$2,912,056.45	$2,272,675.82	$1,079,680.33	$618,556.36
Nursery			13,045,577.23	11,478,483.46	10,185,369.18	8,447,332.30	4,346,550.24	1,335,911.63
Fruit Crops			51,479,587.53	34,562,800.75	26,905,425.97	17,385,218.13	1,543,673.19	0.00
Urban			24,669,774.83	11,904,773.08	8,872,090.28	6,749,192.23	1,067,743.08	298,220.91
Sum:			$93,550,838.26	$61,344,460.17	$48,874,941.88	$34,854,418.48	$8,037,646.84	$2,252,688.90

Table 19
Expected Damage Potential
Without Project Conditions
2006 Land Use Condition
No Frog Pond Land Purchases

Full Production Field Crop Flood Damage			SPF 45,782,717.42	100yr 35,718,948.15	50yr 30,607,199.01	25yr 23,886,982.39	10yr 11,347,991.10	2yr 6,501,342.88
Date or Growing Season (Mid-month)	% chance occurrence	Average Basin wide % of total production costs	SPF Adjusted Frequency Damage	100yr Adjusted Frequency Damage	50yr Adjusted Frequency Damage	25yr Adjusted Frequency Damage	10yr Adjusted Frequency Damage	2yr Adjusted Frequency Damage
January	0.00%	30.95%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
February	2.00%	20.93%	$191,628.14	$149,505.23	$128,109.49	$99,981.35	$47,498.15	$27,212.02
March	3.00%	26.70%	$366,747.04	$286,130.21	$245,182.03	$191,349.06	$90,904.22	$52,079.66
April	5.00%	7.04%	$161,178.06	$125,748.56	$107,752.64	$84,094.12	$39,950.60	$22,887.98
May	11.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
June	20.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
July	2.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
August	12.00%	0.09%	$5,015.95	$3,913.37	$3,353.32	$2,617.06	$1,243.29	$712.29
September	23.00%	11.19%	$1,178,731.00	$919,627.18	$788,019.07	$614,999.03	$292,167.65	$167,384.87
October	20.00%	23.23%	$2,126,973.49	$1,659,430.89	$1,421,949.25	$1,109,741.43	$527,204.97	$302,039.39
November	2.00%	35.56%	$325,625.00	$254,047.45	$217,690.64	$169,893.77	$80,711.45	$46,240.15
December	0.00%	24.73%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Field Crops	100.00%		$4,355,898.67	$3,398,402.88	$2,912,056.45	$2,272,675.82	$1,079,680.33	$618,556.36
Nursery			13,045,577.23	11,478,483.46	10,185,369.18	8,447,332.30	4,346,550.24	1,335,911.63
Fruit Crops			54,278,403.25	36,129,811.19	28,024,553.12	18,080,520.06	1,607,819.32	0.00
Urban			24,669,774.83	11,904,773.08	8,872,090.28	6,749,192.23	1,067,743.08	298,220.91
Sum:			$96,349,653.98	$62,911,470.61	$49,994,069.03	$35,549,720.41	$8,101,792.97	$2,252,688.90

Table 20
Damage Potential
Fruit Crops, Nurseries, and Urban
Plans 1,1A Project Condition
2001 Land Use Condition
No Frog Pond Purchases

Land Use	SPF	100yr	50yr	25yr	10yr	2yr
Limes	714,234.66	215,588.28	102,480.62	35,309.55	0.00	0.00
Mangos	704,777.67	386,880.81	275,773.64	106,736.14	3,397.41	0.00
Avocados	31,836,241.43	24,201,621.21	19,323,323.25	9,564,040.15	0.00	0.00
Papaya	1,028,480.00	657,437.48	235,440.00	208,280.00	110,040.00	0.00
Maturing Limes	75,972.68	0.00	0.00	0.00	0.00	0.00
Maturing Mangos	0.00	0.00	0.00	0.00	0.00	0.00
Maturing Avocadoes	7,033,047.02	5,286,591.27	4,243,538.32	2,044,877.41	0.00	0.00
Total Fruit Crops	41,392,753.46	30,748,119.05	24,180,555.83	11,959,243.25	113,437.41	0.00
Nursery	8,838,798.58	6,646,146.80	5,468,346.21	3,373,662.23	0.00	0.00
Urban	17,974,922.74	8,338,044.71	5,864,880.23	5,208,404.56	222,387.24	0.00

Table 21
Full Production Damage Potential
Vegetable Crops
Plans 1,1A Project Condition
2001 Land Use Condition
No Frog Pond Purchases

Land Use	SPF	100yr	50yr	25yr	10yr	2yr
Tomatoes	25,047,171.37	16,568,341.29	15,637,586.92	12,746,343.08	7,688,192.98	2,453,108.74
Potatoes	1,081,940.63	970,985.95	883,800.44	636,780.51	77,626.28	12,801.19
Squash	1,562,137.30	1,327,430.27	1,084,970.21	827,672.72	244,129.90	77,426.74
Snap Beans	2,848,460.64	2,246,209.59	1,960,171.87	1,185,559.62	102,838.72	0.00
Pole Beans	31,139.50	23,730.50	23,730.50	20,072.50	0.00	0.00
Cabbage	34,890.01	34,890.01	34,890.01	34,890.01	0.00	0.00
Corn	2,049,842.40	1,419,372.14	1,273,312.84	869,650.64	48,183.71	33,066.70
Lettuce	405,353.60	405,353.60	405,353.60	405,353.60	0.00	0.00
Peppers	330,427.29	330,427.29	280,196.17	167,845.45	0.00	0.00
Sweet Potatoes	134,451.00	88,488.00	52,407.00	52,407.00	0.00	0.00
Malanga	444,353.00	444,353.00	444,353.00	394,784.00	153,046.52	64,415.00
Calabanza	253,506.25	240,350.00	227,793.75	174,418.75	59,712.50	0.00
Okra	302,854.67	223,268.63	183,709.30	138,051.21	0.00	0.00
Yuca	308,556.00	282,654.00	221,462.66	151,254.00	0.00	0.00
Mixed Vegetables	3,270,759.65	2,529,594.09	1,904,988.75	1,080,284.20	53,860.34	0.00
Cucumbers	124,055.54	6,228.97	6,228.97	0.00	0.00	0.00
General Agriculture	441,811.10	441,811.10	441,811.10	74,994.35	0.00	0.00
Field Crops	38,671,709.95	27,583,488.43	25,066,767.09	18,960,361.64	8,427,590.95	2,640,818.37

Table 22
Expected Damage Potential
Plans 1,1A Project Conditions
2001 Land Use Condition
No Frog Pond Purchases

Full Production Field Crop Flood Damage			SPF	100yr	50yr	25yr	10yr	2yr
			38,671,709.95	27,583,488.43	25,066,767.09	18,960,361.64	8,427,590.95	2,640,818.37

Date or Growing Season (Mid-month)	% chance occurrence	Average Basin wide % of total production costs	SPF Adjusted Frequency Damage	100yr Adjusted Frequency Damage	50yr Adjusted Frequency Damage	25yr Adjusted Frequency Damage	10yr Adjusted Frequency Damage	2yr Adjusted Frequency Damage
January	0.00%	30.95%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
February	2.00%	20.93%	$161,864.31	$115,453.45	$104,919.46	$79,360.49	$35,274.52	$11,053.41
March	3.00%	26.70%	$309,783.60	$220,960.29	$200,799.84	$151,883.87	$67,510.06	$21,154.54
April	5.00%	7.04%	$136,143.75	$97,107.67	$88,247.55	$66,749.95	$29,669.33	$9,297.00
May	11.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
June	20.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
July	2.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
August	12.00%	0.09%	$4,236.87	$3,022.05	$2,746.32	$2,077.30	$923.33	$289.33
September	23.00%	11.19%	$995,649.58	$710,170.01	$645,374.00	$488,157.26	$216,978.44	$67,991.04
October	20.00%	23.23%	$1,796,610.30	$1,281,473.71	$1,164,551.87	$880,860.48	$391,529.02	$122,687.14
November	2.00%	35.56%	$275,048.67	$196,184.80	$178,284.87	$134,853.68	$59,940.40	$18,782.56
December	0.00%	24.73%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Field Crops	100.00%		$3,679,337.09	$2,624,371.98	$2,384,923.91	$1,803,943.03	$801,825.11	$251,255.01
Nursery			8,838,798.58	6,646,146.80	5,468,346.21	3,373,662.23	0.00	0.00
Fruit Crops			41,392,753.46	30,748,119.05	24,180,555.83	11,959,243.25	113,437.41	0.00
Urban			17,974,922.74	8,338,044.71	5,864,880.23	5,208,404.56	222,387.24	0.00
Sum:			$71,885,811.87	$48,356,682.54	$37,898,706.18	$22,345,253.07	$1,137,649.76	$251,255.01

Table 23
Expected Damage Potential
Plans 1,1A Project Conditions
2006 Land Use Condition
No Frog Pond Purchases

	SPF	100yr	50yr	25yr	10yr	2yr
Full Production Field Crop Flood Damage	38,671,709.95	27,583,488.43	25,066,767.09	18,960,361.64	8,427,590.95	2,640,818.37

Date or Growing Season (Mid-month)	% chance occurrence	Average Basin wide % of total production costs	SPF Adjusted Frequency Damage	100yr Adjusted Frequency Damage	50yr Adjusted Frequency Damage	25yr Adjusted Frequency Damage	10yr Adjusted Frequency Damage	2yr Adjusted Frequency Damage
January	0.00%	30.95%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
February	2.00%	20.93%	$161,864.31	$115,453.45	$104,919.46	$79,360.49	$35,274.52	$11,053.41
March	3.00%	26.70%	$309,783.60	$220,960.29	$200,799.84	$151,883.87	$67,510.06	$21,154.54
April	5.00%	7.04%	$136,143.75	$97,107.67	$88,247.55	$66,749.95	$29,669.33	$9,297.00
May	11.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
June	20.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
July	2.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
August	12.00%	0.09%	$4,236.87	$3,022.05	$2,746.32	$2,077.30	$923.33	$289.33
September	23.00%	11.19%	$995,649.58	$710,170.01	$645,374.00	$488,157.26	$216,978.44	$67,991.04
October	20.00%	23.23%	$1,796,610.30	$1,281,473.71	$1,164,551.87	$880,860.48	$391,529.02	$122,687.14
November	2.00%	35.56%	$275,048.67	$196,184.80	$178,284.87	$134,853.68	$59,940.40	$18,782.56
December	0.00%	24.73%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Field Crops	100.00%		$3,679,337.09	$2,624,371.98	$2,384,923.91	$1,803,943.03	$801,825.11	$251,255.01
Nursery			8,838,798.58	6,646,146.80	5,468,346.21	3,373,662.23	0.00	0.00
Fruit Crops			43,590,977.53	32,076,738.45	25,126,448.24	12,455,108.81	114,570.37	0.00
Urban			17,974,922.74	8,338,044.71	5,864,880.23	5,208,404.56	222,387.24	0.00
Sum:			$74,084,035.94	$49,685,301.94	$38,844,598.59	$22,841,118.63	$1,138,782.72	$251,255.01

Table 24
Expected Damage Potential
Plan 2 Project Conditions
2001 Land Use Condition
West 1/2 of Frog Pond Removed

Full Production Field Crop Flood Damage			SPF	100yr	50yr	25yr	10yr	2yr
			35,026,954.20	23,938,732.68	21,422,011.34	15,315,605.88	4,924,004.23	858,081.22
Date or Growing Season (Mid-month)	% chance occurrence	Average Basin wide % of total production costs	SPF Adjusted Frequency Damage	100yr Adjusted Frequency Damage	50yr Adjusted Frequency Damage	25yr Adjusted Frequency Damage	10yr Adjusted Frequency Damage	2yr Adjusted Frequency Damage
January	0.00%	30.95%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
February	2.00%	20.93%	$146,608.82	$100,197.96	$89,663.97	$64,105.00	$20,609.91	$3,591.58
March	3.00%	26.70%	$280,586.92	$191,763.61	$171,603.16	$122,687.19	$39,444.23	$6,873.75
April	5.00%	7.04%	$123,312.39	$84,276.31	$75,416.19	$53,918.59	$17,334.96	$3,020.87
May	11.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
June	20.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
July	2.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
August	12.00%	0.09%	$3,837.55	$2,622.73	$2,347.00	$1,677.98	$539.47	$94.01
September	23.00%	11.19%	$901,810.97	$616,331.40	$551,535.39	$394,318.65	$126,774.40	$22,092.33
October	20.00%	23.23%	$1,627,282.24	$1,112,145.64	$995,223.80	$711,532.42	$228,759.39	$39,864.74
November	2.00%	35.56%	$249,125.71	$170,261.84	$152,361.91	$108,930.72	$35,021.49	$6,103.02
December	0.00%	24.73%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Field Crops	100.00%		$3,332,564.60	$2,277,599.49	$2,038,151.43	$1,457,170.55	$468,483.85	$81,640.30
Nursery			8,838,798.58	6,646,146.80	5,468,346.21	3,373,662.23	0.00	0.00
Fruit Crops			41,392,753.46	30,748,119.05	24,180,555.83	11,959,243.25	113,437.41	0.00
Urban			17,974,922.74	8,338,044.71	5,864,880.23	5,208,404.56	222,387.24	0.00
Sum:			$71,539,039.38	$48,009,910.05	$37,551,933.70	$21,998,480.59	$804,308.50	$81,640.30

Table 25
Expected Damage Potential
Plan 2 Project Conditions
2006 Land Use Condition
West 1/2 of Frog Pond Removed

Full Production Field Crop Flood Damage			SPF 35,026,954.20	100yr 23,938,732.68	50yr 21,422,011.34	25yr 15,315,605.88	10yr 4,924,004.23	2yr 858,081.22
Date or Growing Season (Mid-month)	% chance occurrence	Average Basin wide % of total production costs	SPF Adjusted Frequency Damage	100yr Adjusted Frequency Damage	50yr Adjusted Frequency Damage	25yr Adjusted Frequency Damage	10yr Adjusted Frequency Damage	2yr Adjusted Frequency Damage
January	0.00%	30.95%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
February	2.00%	20.93%	$146,608.82	$100,197.96	$89,663.97	$64,105.00	$20,609.91	$3,591.58
March	3.00%	26.70%	$280,586.92	$191,763.61	$171,603.16	$122,687.19	$39,444.23	$6,873.75
April	5.00%	7.04%	$123,312.39	$84,276.31	$75,416.19	$53,918.59	$17,334.96	$3,020.87
May	11.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
June	20.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
July	2.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
August	12.00%	0.09%	$3,837.55	$2,622.73	$2,347.00	$1,677.98	$539.47	$94.01
September	23.00%	11.19%	$901,810.97	$616,331.40	$551,535.39	$394,318.65	$126,774.40	$22,092.33
October	20.00%	23.23%	$1,627,282.24	$1,112,145.64	$995,223.80	$711,532.42	$228,759.39	$39,864.74
November	2.00%	35.56%	$249,125.71	$170,261.84	$152,361.91	$108,930.72	$35,021.49	$6,103.02
December	0.00%	24.73%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Field Crops	100.00%		$3,332,564.60	$2,277,599.49	$2,038,151.43	$1,457,170.55	$468,483.85	$81,640.30
Nursery			8,838,798.58	6,646,146.80	5,468,346.21	3,373,662.23	0.00	0.00
Fruit Crops			43,590,977.53	32,076,738.45	25,126,448.24	12,455,108.81	114,570.37	0.00
Urban			17,974,922.74	8,338,044.71	5,864,880.23	5,208,404.56	222,387.24	0.00
Sum:			$73,737,263.45	$49,338,529.45	$38,497,826.11	$22,494,346.15	$805,441.46	$81,640.30

Table 26
Expected Damage Potential
Plans 3, 4, 5, 6, and 6A Project Conditions
2001 Land Use Condition
Total Frog Pond Removed

Full Production Field Crop Flood Damage			SPF	100yr	50yr	25yr	10yr	2yr
			27,970,842.10	18,340,362.40	15,823,641.04	10,096,211.01	985,510.10	228,810.49
Date or Growing Season (Mid-month)	% chance occurrence	Average Basin wide % of total production costs	SPF Adjusted Frequency Damage	100yr Adjusted Frequency Damage	50yr Adjusted Frequency Damage	25yr Adjusted Frequency Damage	10yr Adjusted Frequency Damage	2yr Adjusted Frequency Damage
January	0.00%	30.95%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
February	2.00%	20.93%	$117,074.76	$76,765.42	$66,231.43	$42,258.70	$4,124.95	$957.71
March	3.00%	26.70%	$224,063.23	$146,917.31	$126,756.86	$80,876.71	$7,894.53	$1,832.91
April	5.00%	7.04%	$98,471.35	$64,567.25	$55,707.13	$35,543.71	$3,469.49	$805.53
May	11.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
June	20.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
July	2.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
August	12.00%	0.09%	$3,064.49	$2,009.37	$1,733.64	$1,106.14	$107.97	$25.07
September	23.00%	11.19%	$720,142.89	$472,194.64	$407,398.63	$259,939.07	$25,373.14	$5,891.00
October	20.00%	23.23%	$1,299,469.38	$852,056.56	$735,134.72	$469,049.77	$45,784.83	$10,630.08
November	2.00%	35.56%	$198,939.82	$130,443.99	$112,544.06	$71,808.29	$7,009.34	$1,627.39
December	0.00%	24.73%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Field Crops	100.00%		$2,661,225.91	$1,744,954.53	$1,505,506.46	$960,582.39	$93,764.25	$21,769.68
Nursery			8,838,798.58	6,646,146.80	5,468,346.21	3,373,662.23	0.00	0.00
Fruit Crops			41,392,753.46	30,748,119.05	24,180,555.83	11,959,243.25	113,437.41	0.00
Urban			17,974,922.74	8,338,044.71	5,864,880.23	5,208,404.56	222,387.24	0.00
Sum:			$70,867,700.69	$47,477,265.09	$37,019,288.73	$21,501,892.43	$429,588.90	$21,769.68

Table 27
Expected Damage Potential
Plans 3, 4, 5, 6, and 6A Project Conditions
2006 Land Use Condition
Total Frog Pond Removed

			SPF	100yr	50yr	25yr	10yr	2yr
Full Production Field Crop Flood Damage			27,970,842.10	18,340,362.40	15,823,641.04	10,096,211.01	985,510.10	228,810.49
Date or Growing Season (Mid-month)	% chance occurrence	Average Basin wide % of total production costs	SPF Adjusted Frequency Damage	100yr Adjusted Frequency Damage	50yr Adjusted Frequency Damage	25yr Adjusted Frequency Damage	10yr Adjusted Frequency Damage	2yr Adjusted Frequency Damage
January	0.00%	30.95%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
February	2.00%	20.93%	$117,074.76	$76,765.42	$66,231.43	$42,258.70	$4,124.95	$957.71
March	3.00%	26.70%	$224,063.23	$146,917.31	$126,756.86	$80,876.71	$7,894.53	$1,832.91
April	5.00%	7.04%	$98,471.35	$64,567.25	$55,707.13	$35,543.71	$3,469.49	$805.53
May	11.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
June	20.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
July	2.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
August	12.00%	0.09%	$3,064.49	$2,009.37	$1,733.64	$1,106.14	$107.97	$25.07
September	23.00%	11.19%	$720,142.89	$472,194.64	$407,398.63	$259,939.07	$25,373.14	$5,891.00
October	20.00%	23.23%	$1,299,469.38	$852,056.56	$735,134.72	$469,049.77	$45,784.83	$10,630.08
November	2.00%	35.56%	$198,939.82	$130,443.99	$112,544.06	$71,808.29	$7,009.34	$1,627.39
December	0.00%	24.73%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Field Crops	100.00%		$2,661,225.91	$1,744,954.53	$1,505,506.46	$960,582.39	$93,764.25	$21,769.68
Nursery			8,838,798.58	6,646,146.80	5,468,346.21	3,373,662.23	0.00	0.00
Fruit Crops			43,590,977.53	32,076,738.45	25,126,448.24	12,455,108.81	114,570.37	0.00
Urban			17,974,922.74	8,338,044.71	5,864,880.23	5,208,404.56	222,387.24	0.00
Sum:			$73,065,924.76	$48,805,884.49	$37,965,181.14	$21,997,757.99	$430,721.86	$21,769.68

Table 28
Average Annual Damage Summary
Damage in ($)
2001 Land Use

Frequency	No Frog Pond Purchased Without Project	No Frog Pond Purchased Plans 1,1A	West Frog Pond Purchased Without Project	West Frog Pond Purchased Plan 2	Total Frog Pond Purchased Without Project	Total Frog Pond Purchased Plans 3,4,5,6,6A
SPF	$93,550,838	$71,885,812	$93,204,066	$71,539,039	$92,530,374	$70,867,701
100 Year	$61,344,460	$48,356,683	$60,997,688	$48,009,910	$60,435,754	$47,477,265
50 Year	$48,874,942	$37,898,706	$48,528,169	$37,551,934	$47,979,112	$37,019,289
25 Year	$34,854,418	$22,345,253	$34,507,646	$21,998,481	$33,959,013	$21,501,892
10 Year	$8,037,647	$1,137,650	$7,690,874	$804,309	$7,297,388	$429,589
2 Year	$2,252,689	$251,255	$1,919,348	$81,640	$1,685,033	$21,770
Average Annual	$5,366,800	$2,310,300	$5,157,600	$2,242,000	$4,698,600	$1,984,800

Table 29
Average Annual Damage Summary
Damage in ($)
2006 Land Use

Frequency	No Frog Pond Purchased Without Project	No Frog Pond Purchased Plans 1,1A	West Frog Pond Purchased Without Project	West Frog Pond Purchased Plan 2	Total Frog Pond Purchased Without Project	Total Frog Pond Purchased Plans 3,4,5,6,6A
SPF	$96,349,654	$74,084,036	$96,002,882	$73,737,263	$95,329,190	$73,065,925
100 Year	$62,911,471	$49,685,302	$62,564,698	$49,338,529	$62,002,764	$48,805,884
50 Year	$49,994,069	$38,844,599	$49,647,297	$38,497,826	$49,098,239	$37,965,181
25 Year	$35,549,720	$22,841,119	$35,202,948	$22,494,346	$34,654,314	$21,997,758
10 Year	$8,101,793	$1,138,783	$7,755,020	$805,441	$7,361,534	$430,722
2 Year	$2,252,689	$251,255	$1,919,348	$81,640	$1,685,033	$21,770
Average Annual	$5,560,500	$2,361,900	$5,271,800	$2,293,500	$5,008,500	$2,071,000

Table 30
Average Annual Equivalent Benefit Evaluation
Values Amortized and Discounted at 8%
(in $)

	No Frog Pond Purchased Without Project	No Frog Pond Purchased Plans 1,1A	West Frog Pond Purchased Without Project	West Frog Pond Purchased Plan 2	Total Frog Pond Purchased Without Project	Total Frog Pond Purchased Plans 3,4,5,6,6A
Average Annual 2001 Land Use	$5,366,800	$2,310,300	$5,157,600	$2,242,000	$4,698,600	$1,984,800
Average Annual 2006 Land Use	$5,560,500	$2,361,900	$5,271,800	$2,293,500	$5,008,500	$2,071,000
Average Annual Equivalent	$5,533,300	$2,354,600	$5,255,700	$2,286,300	$4,964,900	$2,058,900
Average Annual Equivalent Flood Damages Prevented		$3,178,700		$2,969,400		$2,906,000

Table 31
Project Benefit and Cost Summary
Values Amortized and Discounted at 8%
(in $)

	Alternative 1	Alternative 1A	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 6A
Construction Cost	36,529,775	26,222,075	38,726,895	54,951,640	77,636,106	42,260,805	71,239,100	70,723,200
Lands	286,175	280,075	6,943,750	19,820,250	50,690,000	19,826,500	50,690,000	50,690,000
Total Construction Cost	36,815,950	26,502,150	45,670,645	74,771,890	128,326,106	62,087,305	121,929,100	121,413,200
Interest During Construction	8,023,727	5,759,652	8,506,323	12,070,071	17,052,691	9,282,542	15,647,595	15,534,278
Total Project Investment	44,839,677	32,261,802	54,176,968	86,841,961	145,378,797	71,369,847	137,576,695	136,947,478
Interest and Amortization	3,665,323	2,637,172	4,428,580	7,098,710	11,883,678	5,833,975	11,245,912	11,194,478
Annualized Replacements	34,158	34,158	34,999	70,452	67,532	41,203	54,322	96,914
Operation and Maintenance	357,550	353,750	384,550	536,194	934,694	478,694	891,550	747,900
Total Annual Equivalent Costs	4,057,031	3,025,080	4,848,129	7,705,356	12,885,904	6,353,872	12,191,784	12,039,292
Total Annual Equivalent Benefits	3,178,700	3,178,700	2,969,400	2,906,000	2,906,000	2,906,000	2,906,000	2,906,000

Table 32
Project Benefit and Cost Summary
Values Amortized and Discounted at 6%
(in $)

	Alternative 1	Alternative 1A	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 6A
Construction Cost	36,529,775	26,222,075	38,726,895	54,951,640	77,636,106	42,260,805	71,239,100	70,723,200
Lands	286,175	280,075	6,943,750	19,820,250	50,690,000	19,826,500	50,690,000	50,690,000
Total Construction Cost	36,815,950	26,502,150	45,670,645	74,771,890	128,326,106	62,087,305	121,929,100	121,413,200
Interest During Construction	5,878,063	4,219,435	6,231,605	8,842,354	12,492,547	6,800,252	11,463,195	11,380,180
Total Project Investment	42,694,013	30,721,585	51,902,250	83,614,244	140,818,653	68,887,557	133,392,295	132,793,380
Interest and Amortization	2,708,691	1,949,109	3,292,901	5,304,846	8,934,139	4,370,522	8,462,979	8,424,981
Annualized Replacements	42,366	42,366	43,367	87,296	83,677	51,054	67,309	120,026
Operation and Maintenance	357,550	353,750	384,550	536,194	934,694	478,694	891,550	747,900
Total Annual Equivalent Costs	3,108,607	2,345,225	3,720,818	5,928,336	9,952,510	4,900,270	9,421,838	9,292,907
Total Annual Equivalent Benefits	3,178,700	3,178,700	2,969,400	2,906,000	2,906,000	2,906,000	2,906,000	2,906,000

Table 33
Project Benefit and Cost Summary
Values Amortized and Discounted at 2.5%
(in $)

	Alternative 1	Alternative 1A	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 6A
Construction Cost	36,529,775	26,222,075	38,726,895	54,951,640	77,636,106	42,260,805	71,239,100	70,723,200
Lands	286,175	280,075	6,943,750	19,820,250	50,690,000	19,826,500	50,690,000	50,690,000
Total Construction Cost	36,815,950	26,502,150	45,670,645	74,771,890	128,326,106	62,087,305	121,929,100	121,413,200
Interest During Construction	2,350,773	1,687,450	2,492,163	3,536,262	4,996,059	2,719,578	4,584,397	4,551,198
Total Project Investment	39,166,723	28,189,600	48,162,808	78,308,152	133,322,165	64,806,883	126,513,497	125,964,398
Interest and Amortization	1,380,943	993,911	1,698,127	2,760,993	4,700,680	2,284,965	4,460,620	4,441,260
Annualized Replacements	54,450	54,450	55,791	112,303	107,650	65,679	86,593	154,416
Operation and Maintenance	357,550	353,750	384,550	536,194	934,694	478,694	891,550	747,900
Total Annual Equivalent Costs	1,792,943	1,402,111	2,138,468	3,409,490	5,743,024	2,829,338	5,438,763	5,343,575
Total Annual Equivalent Benefits	3,178,700	3,178,700	2,969,400	2,906,000	2,906,000	2,906,000	2,906,000	2,906,000

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Appendix E
Social and Economic Analysis

FIGURES

Figure E-1
Floodprone Area Without Project

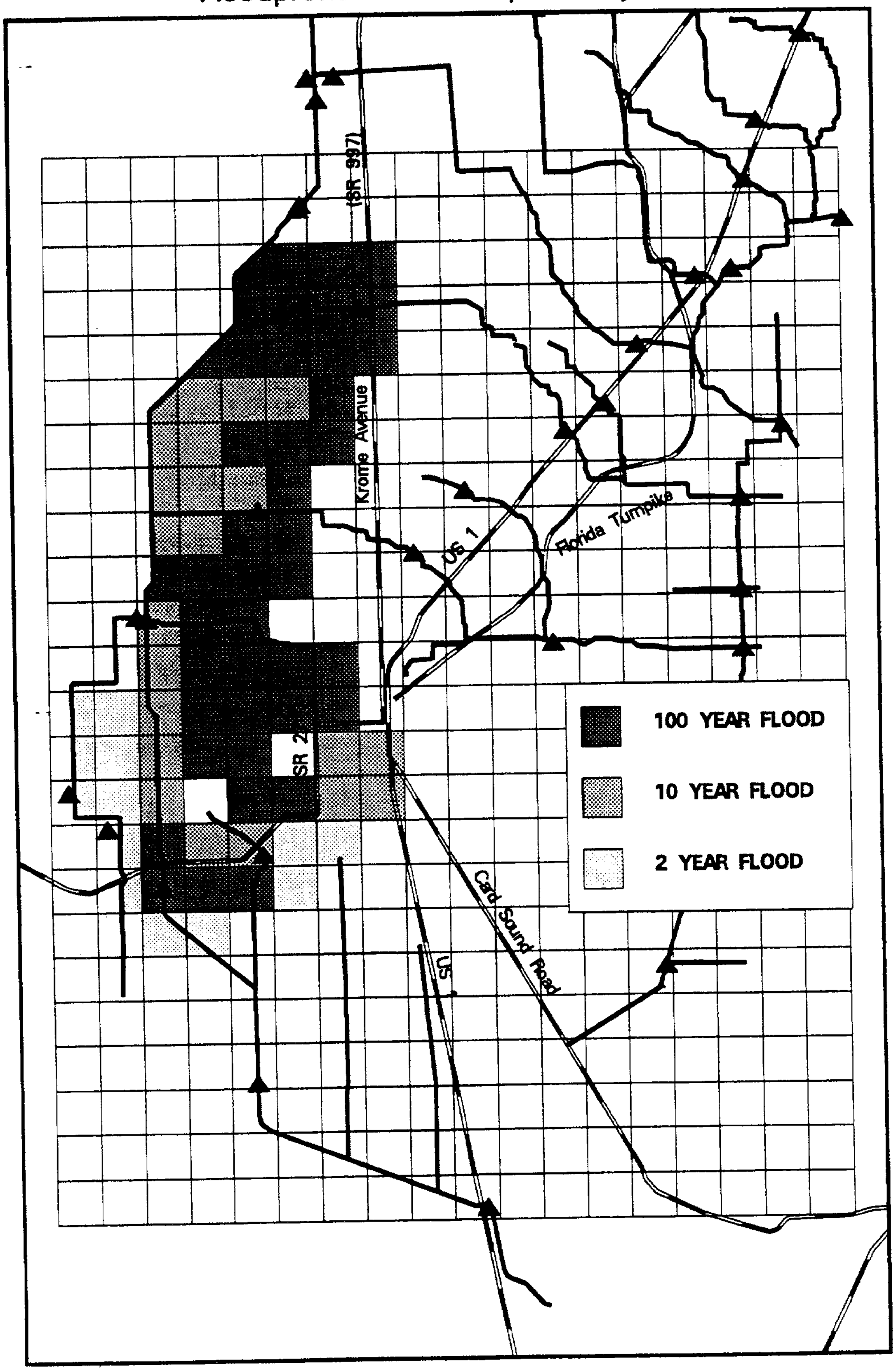
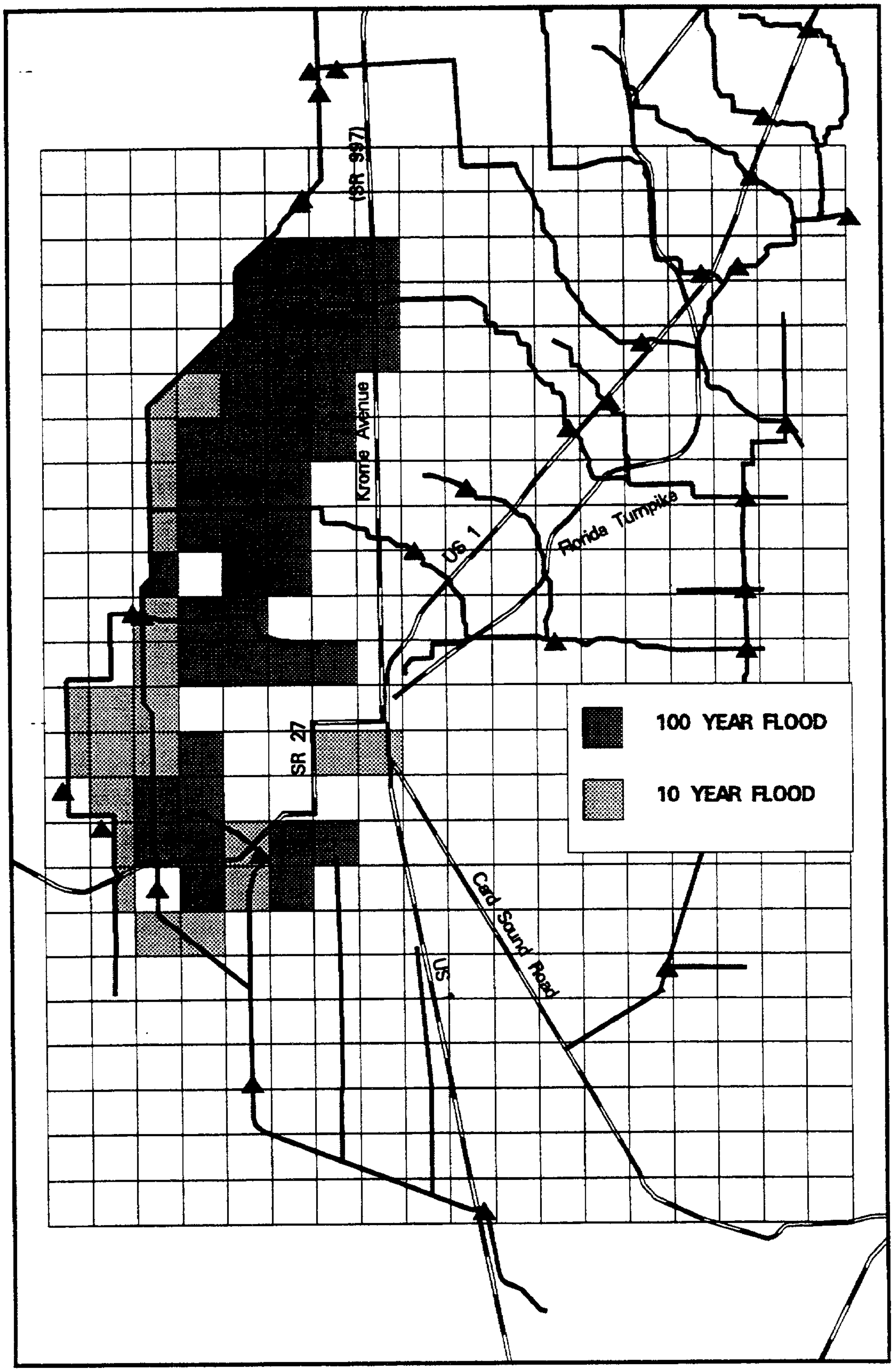


Figure E-2
Floodprone Area With Project



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Appendix F
1988 General Design Memorandum
Formulation of Alternative Plans

1. Authority. Authority to prepare the 1988 Addendum to the General Design Memorandum were the 1962 and 1968 Flood Control Acts.

2. Study Purpose and Constraints. This 1988 report was prepared in General Design Memorandum (GDM) scope and covered the Canal 111 (C-111) basin and other parts of the Central and Southern Florida Project which affected flows to and through the basin. The purpose of the study was to complete the authorized plan of improvement for flood control, environmental enhancement and water management in the C-111 basin as constructed in the 1960's. A major focus of the study was the difficulty in system management and loss of benefits resulting from a temporary solution to an environmental problem, the S-197 culvert structure and plug near U.S. Highway 1. This problem occurred during initial construction of the canal. This report provides a solution to the problem that insures the authorized flood protection and vastly increases management options for the benefit of the environment and the economy.

3. Planning Objectives. This Corps study began in 1983 and continued until submittal in 1988. Over the years concern for the lack of flood protection resulting from the temporary culvert structure S-197 and plug located in C-111 near U.S. Highway 1. The structure and plug were a temporary solution to the problem of potential salt water intrusion into the surficial aquifer and surface waters of the Everglades National Park via the canal. The plug was removed during flood events to use the conveyance of C-111 and relieve flooding upstream. The coordination and removal of this plug was slow and cumbersome. Reinstallation of the plug required closing S-18C, which caused water levels to rise upstream. The fines in the plug material were lost due to repeated removal and installation so that the plug was no longer a barrier to water movement through the plug when there is any head differential across it. Additionally, when the plug was removed, the water flowed uncontrolled into Barnes Sound, introducing a large component of fresh water into an estuarine system. This resulted in very little water flowing overland from the canal toward Florida Bay.

To develop and analyze potential solutions to water resource problems certain goals and objectives were defined. The objectives for this study were:

a. Develop a plan that would provide the flood protection authorized for the South Dade County area, which is defined as 40 percent of the SPF (which approximates a 10-year return).

b. Reintroduce sheetflow to the marsh adjacent to C-111 and to northeast Florida Bay via Everglades National Park that would be of sufficient frequency and duration to restore modern historic ecosystem conditions.

c. Reduce large freshwater flows to Barnes Sound.

d. Protect, preserve, or minimize impacts on significant historic or cultural resources.

Plans were formulated to meet the Federal objective of water and related land resources project planning.

4. Plan Criteria. There were four criteria to consider in developing alternatives. These criteria were:

a. Completeness -- The extent to which a given plan provides and accounts for all necessary investments or other actions to ensure the realization of plan benefits.

b. Effectiveness -- The extent to which a plan alleviates the problems and achieves the study objectives.

c. Efficiency -- The extent to which a plan is most cost effective in alleviating the problems, achieves the objectives, and is consistent with protecting the Nation's environment.

d. Acceptability -- The workability and viability of a plan with respect to its acceptance by State and local entities, the public, and its compatibility with existing laws, regulations, and public policies.

5. Alternative Plans Considered. Alternative plans of action were formulated and evaluated to accomplish the study objectives. Because of the nature of the problems addressed, a solely non-structural plan was not found to be an effective measure to accomplish the objectives of the study. Combinations of structural and non-structural components were determined to be the most feasible options for implementation to meet these objectives.

Several alternative plans were suggested by various interest groups which focused on environmental restoration of the lower basin, rather than on the overall objectives. The main objective of the study was to formulate an economically justified plan which would complete the construction in the C-111 basin in a manner that would provide the authorized flood protection while providing maximum flexibility of operation for environmental purposes, both inside and outside of the Everglades National Park. Some of the alternatives considered are list in the following paragraphs.

a. No Action Alternative. This alternative would maintain the existing project as it is currently configured. This plan was not determined feasible because change was needed both for flood control and environmental purposes.

b. Plan A -- Eastern Floodway. This proposal would eliminate nearly all of C-111 from S-18C south and create a large continuous marsh. The marsh would be about 4 miles wide and extend from an area 2 miles north of S-18C to northeast Florida Bay. Overland flow in the marsh would be dependent on local rainfall plus water pumped into the north end of the area from C-111. Major components included: backfilling of C-111 from the bend below S-18C to Manatee Bay; provide a pumping station and distribution canal above S-18C; and backfill Canals 110 and 109. Estimated cost for this plan would exceed $19 million. Operation and maintenance costs would be continuous for pumping. No improvements would be generated in the upstream portion of the basin. There would be no economic benefits derived because the plan would continue the status quo upstream. Further there would be no positive drainage outlet for large storms, if needed.

c. Plan B -- Eastern Impoundment. This proposal would create a 15-square-mile impoundment north of C-111 with the canal partially backfilled from the bend south of S-18C to U.S. Highway 1. C-111 would be completely backfilled from U.S. 1 to Barnes Sound. A pump station and distribution canal would be provided to place large flows from C-111 into the impoundment. Flood waters in the impoundment area would be released during the dry season, if available. The initial estimated cost for this plan would be $15.8 million. Operation and maintenance costs would be continuous for pump operations. No economic benefits would be gained since the ability to remove flood waters upstream remains the same. There would be no positive outlet for drainage from large storms, if needed.

d. Plan C -- Western Floodway. This alternative would be used in conjunction with the Eastern Floodway or Eastern Impoundment proposals. A structure or pump station would be located in the western levee of C-111 placing excess water into an improved channel along side the Aerojet access road. The water would flow south from the canal overland toward Florida Bay. Initial costs for this alternative would be approximately $20 million. The placement of water in the western portion of the basin could adversely affect the Cape Sable Seaside Sparrow, an endangered species.

e. Plan D -- Low Level Dike. This proposal would provide for a lowlevel dike to be constructed near the existing active agricultural area. The dike would be located between the 4- and 5-foot elevation contours from L-31W eastward. This alternative would eliminate most of C-111 from S-18C south and restore about 25 sections of wetlands. The major elements would include backfilling C-111 from U.S. Highway 1 to Barnes South and partial C-109, and providing pump station at C-111 and C-111E where they pass through the dike. Initial cost of this plan would be $24.4 million. Operation and maintenance of the pumping stations would be significant. The water levels north of the dike would cause damage to some agricultural areas. Pumps large enough to evacuate the flood waters would be prohibitively expensive.

f. Plan E -- C-111E Culverts. This proposal would effectively eliminate C-111 below S-18C. Water levels at S-18C would be increased and water released east thorough culverts in C-111E. This would restore wetland conditions in the area. Initial costs of this plan were estimated to be approximately $18.3 million. The plan assumes no change to upstream water levels. There are no economic benefits to be derived.

g. Plan F -- Extended Canal 109. This proposal would require that C-109 be improved and extended north then west connecting to C-111E. It also would incorporate the Eastern Floodway plan except that C-111 would remain from its junction with C-109 to Manatee Bay. The plan would allow restoration of a large portion of wetlands while providing some positive drainage from the system. Initial estimated costs for this alternative are \$36.8 million. The plan would duplicate some features of other plans, but at a higher cost. Additionally, the northern leg of the extend canal would tend to reduce ground water levels in the northern portion of the area.

h. Plan G -- Existing Project with New Structure at S-197. This alternative would maintain the existing project upstream of S-197. The plan would replace the plug and S-197 with a water control structure. The structure would pass flood flows during major storm events but remain closed for most discharges (which would go through the C-111 gaps). The structure would allow for gradual increase in releases thus forcing more water through the gaps prior to and after the flood peak. Total waters released to Barnes Sound would be significantly less than with the current structure and plug.

i. Plan H -- Enlargement of Other Existing Canals. This alternative consists of evaluating the feasibility of enlarging other existing C&SF project canals. The canals considered were C-1, C-102, and C-103. Two increased volumes of flow were considered, 500 cfs and 800 cfs. Initial estimated costs were \$12.6 million and \$16.3 million, respectively.

j. Plan I -- Modification of C-111, C-111E and Structures. This alternative would eliminate freshwater flows to Manatee Bay. The plan would include enlarging C-111 from S-176 to S-18C, enlarging C-111E, S-176, S-177, S-178 and the modification of associated culverts. Further analysis of this plan revealed that some discharge capacity was required for larger storms. It was combined with Plan G for further analysis. The need for enlarging S-178 was questioned as development in this portion of the basin had not taken place as envisioned in the original report. It was doubtful that additional drainage was required north of S-178.

6. Other Options. An option was considered that could be used with several alternatives. This consisted of a number of overflow sections placed in the eastern levee of C-111 from S-18C to the junction with C-111E. The headwater at S-18C would be held 0.2 to 0.4 feet higher than current operating criteria. The purpose would be to place low level flows into the eastern marsh when available. This action would enhance the flow to this area and permit more sheetflow through the marsh.

7. Coordination. This study was initiated in cooperation with the South Florida Water Management District (SFWMD), the local sponsor for the project. The uncompleted portion of the authorized C-111 project, the plug and the structure 197, have been discussed intermittently since the 1920's. In 1983 the SFWMD proposed several changes to the project. Coordination with other Federal, State, and local agencies and groups was initiated and maintained throughout the study.

A draft coordination report presenting study alternatives was made available to interested parties in October 1986. Numerous comments were provided in response to the request for input into the study.

8. Rational for Plan Selection. The plan selected for recommendation was the one which both met the planning objectives, and was the most cost effective. It was fully coordinated with the South Florida Water Management District and the Everglades National Park. The proposed alternative as shown on Figure 5, is a combination of Plan I (Modification of C-111, C-111E and Structures) and Plan G (New Structure at S-197). The alternative includes enlarging C-111 from S-176 to S-18C, enlarging C-111E, S-176, S-177, S-178, several culverts and a new permanent structure at S-197. The canal and structure enlargements are needed to provide the authorized degree of protection in the developed area. Structure 197 was needed to protect the Park and Barnes Sound from excessive flows and as a salinity barrier.

This plan would provide the flood protection authorized for the C&SF Project and allow maximum flexibility for environmental purposes. Freshwater discharges to Barnes Sound through C-111 would be significantly reduced with the water directed to northeast Florida Bay. Additionally, daily flows would be diverted, if available and desired, to the marsh east of C-111. The operating criteria for S-197 would be coordinated with the Everglades National Park, the U.S. Fish and Wildlife Service, and the South Florida Water Management District, fully utilizing the results of ongoing environmental studies currently being conducted in the area. Construction would be deferred on Canal 111E and Structure 178 until such time as the drainage basin developed sufficiently to contribute design discharge.

The formulation of the selected plan was driven primarily by developing a least cost alternative to accomplish the planning objectives. Benefits from the agricultural area are more than sufficient to justify the costs. The other alternatives investigated were either more expensive or did not meet the planning objectives. The selected plan was considered to be the NED plan considering the limitations placed on formulation, that there be no change in the authorized level of protection. It should be noted that secondary drainage works must be provided by the local sponsor to realize the maximum economic benefit associated with the recommended plan of action in this report.

The U.S. Fish and Wildlife Service preferred a variation of the selected plan whereby the canal would be backfilled downstream of the U.S. Highway 1 bridge, eliminating the need for S-197. This plan was considered, but rejected because it required all flow from the basin to pass overland thorough ENP. This was considered to be objectionable by the Park, which preferred the flexibility of releasing flows to the coast through S-197 when the Park had too much water.

9. Conclusion. The Corps submitted the report in 1988 but it was returned for revision to include obtaining and integrating the Fish and Wildlife Coordination Act Report, and obtaining current letters of support from the local sponsor and the Everglades National Park.

At an interagency meeting on November 9, 1988, the Fish and Wildlife Service stated that they did not have adequate hydrologic information to do their coordination report and the Everglades National Park stated that other alternatives needed to be addressed, since the current plan recommended too much water going down C-111 and a continuation of inadequate deliveries to Taylor Slough via L-31W.

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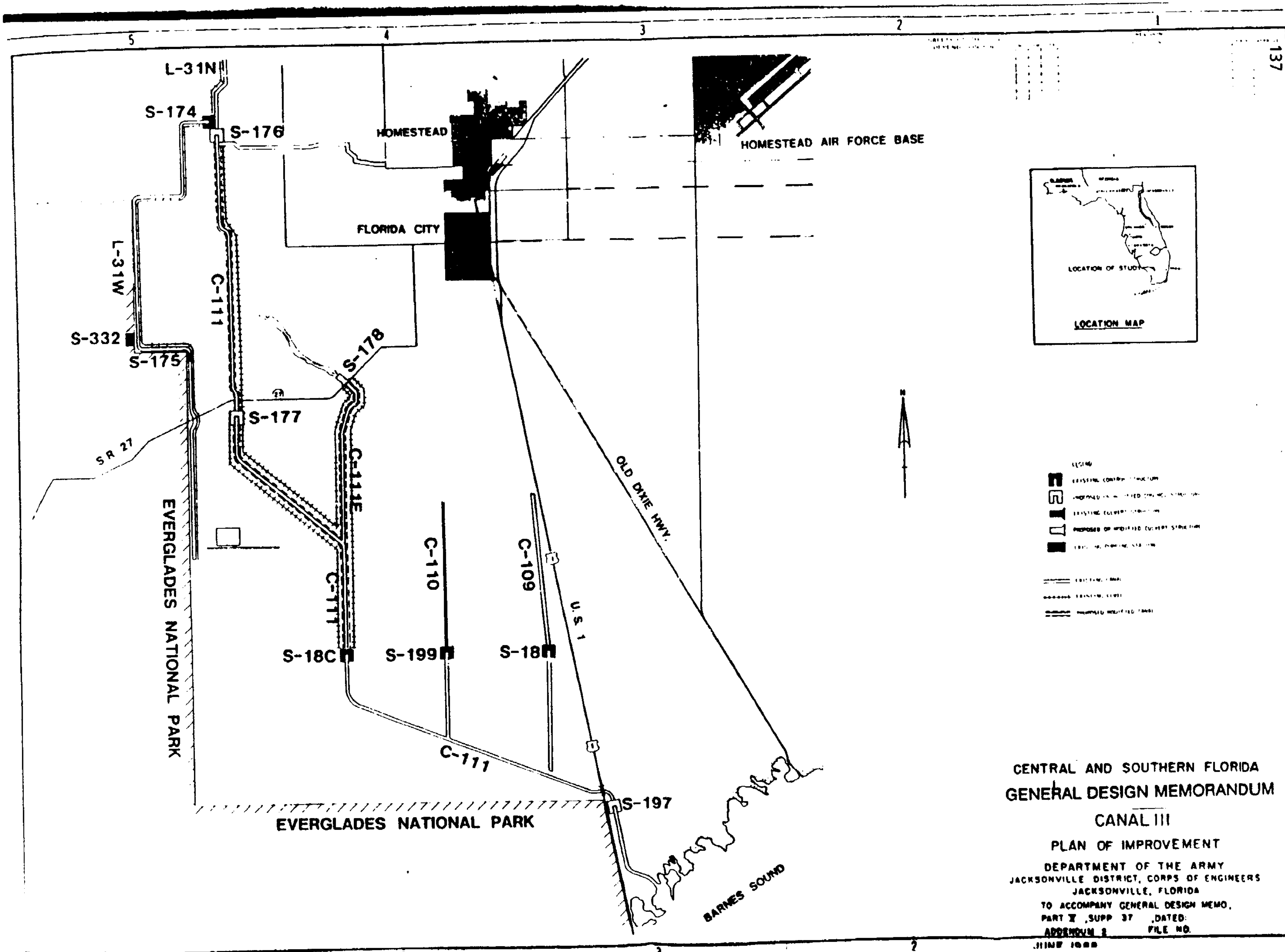
FIGURES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S-174
S-176
HOMESTEAD
HOMESTEAD AIR FORCE BASE
FLORIDA CITY
LOCATION OF STUDY
LOCATION MAP
L-31W
C-111
S-332
S-175
S-178
S-177
SR 27
C-111E
OLD DIXIE HWY.
EVERGLADES NATIONAL PARK
C-110
C-109
U.S. 1
C-111
S-18C
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EVERGLADES NATIONAL PARK
BARNES SOUND
CENTRAL AND SOUTHERN FLORIDA
GENERAL DESIGN MEMORANDUM
CANAL 111
PLAN OF IMPROVEMENT
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
TO ACCOMPANY GENERAL DESIGN MEMO,
PART V, SUPP 37 ,DATED:
FILE NO.